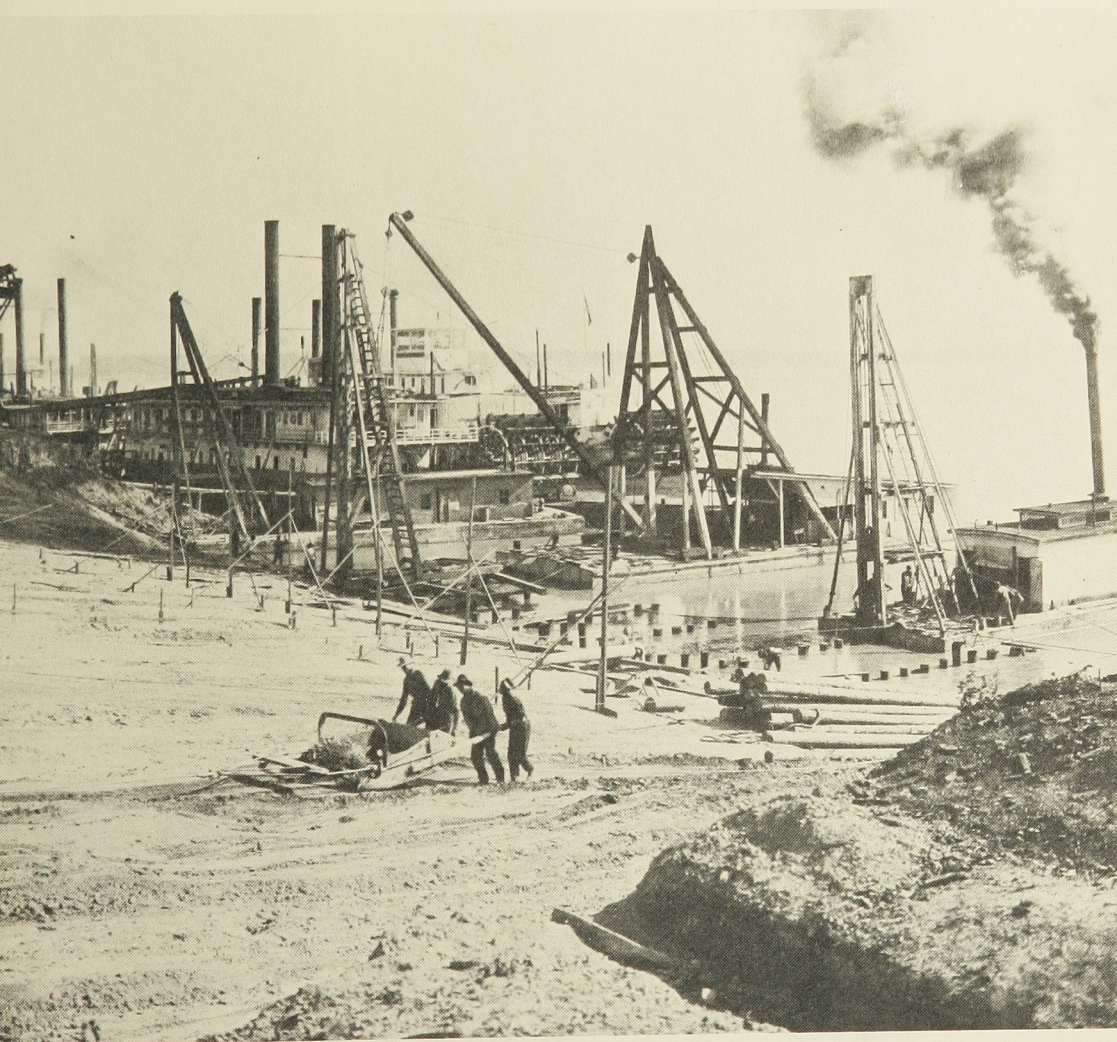


# Army Engineers in Memphis District

A Documentary Chronicle

by

Martin Reuss



| Report Documentation Page  |                                    |                                     |  | Form Approved<br>OMB No. 0704-0188                  |                                    |
|--|------------------------------------|-------------------------------------|--|---|------------------------------------|
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| 1. REPORT DATE<br><b>1982</b>  |                                    | 2. REPORT TYPE                      |  | 3. DATES COVERED<br><b>00-00-1982 to 00-00-1982</b> |                                    |
| 4. TITLE AND SUBTITLE<br><b>Army Engineers in Memphis District: A Documentary Chronicle</b>  |                                    |                                     |  | 5a. CONTRACT NUMBER                                 |                                    |
|  |                                    |                                     |  | 5b. GRANT NUMBER                                    |                                    |
|  |                                    |                                     |  | 5c. PROGRAM ELEMENT NUMBER                          |                                    |
| 6. AUTHOR(S)   |                                    |                                     |  | 5d. PROJECT NUMBER                                  |                                    |
|  |                                    |                                     |  | 5e. TASK NUMBER                                     |                                    |
|  |                                    |                                     |  | 5f. WORK UNIT NUMBER                                |                                    |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><b>U.S. Army Corps of Engineers,Memphis District,167 N. Main Street Rm B-202,Memphis,TN,38103</b>  |                                    |                                     |  | 8. PERFORMING ORGANIZATION<br>REPORT NUMBER         |                                    |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)  |                                    |                                     |  | 10. SPONSOR/MONITOR'S ACRONYM(S)                    |                                    |
|  |                                    |                                     |  | 11. SPONSOR/MONITOR'S REPORT<br>NUMBER(S)           |                                    |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release; distribution unlimited</b>  |                                    |                                     |  |   |                                    |
| 13. SUPPLEMENTARY NOTES  |                                    |                                     |  |   |                                    |
| 14. ABSTRACT   |                                    |                                     |  |   |                                    |
| 15. SUBJECT TERMS  |                                    |                                     |  |   |                                    |
| 16. SECURITY CLASSIFICATION OF:  |                                    |                                     | 17. LIMITATION OF<br>ABSTRACT<br><b>Same as<br/>Report (SAR)</b> | 18. NUMBER<br>OF PAGES<br><b>130</b>                | 19a. NAME OF<br>RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>   | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |  |   |                                    |



## **ON THE COVER**

**Memphis District Engineer Fleet, West Memphis, Arkansas, 1909**

**Official U. S. Army Corps of Engineers photograph**

# **Army Engineers in Memphis District**

**A Documentary Chronicle**

**by**

**Martin Reuss**

**Memphis District  
United States Army Corps of Engineers  
1982**

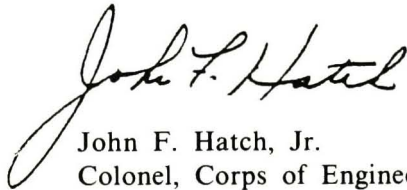




## FOREWORD

This book was prepared to commemorate the centennial of the Memphis District, United States Army Corps of Engineers. It is not designed to be a detailed history. Rather, through the use of biographical profiles, selected documents, and a chronology, Dr. Reuss outlines the role Army Engineers have played in the region the Memphis District presently encompasses. The introductory essay reminds us that the Corps of Engineers began work on the Mississippi River over 150 years ago and has for a century striven to protect Lower Mississippi Valley residents against devastating floods.

While the Corps can look with satisfaction on its record of accomplishment in Memphis District, it cannot afford complacency. New challenges will come and some old ones remain. Nevertheless, I am confident that Memphis District will meet these challenges, thereby confirming both its tradition and its commitment to the people it serves.

A handwritten signature in black ink, reading "John F. Hatch, Jr." in a cursive script.

John F. Hatch, Jr.  
Colonel, Corps of Engineers  
Commander, Memphis District

## The Author

Martin Reuss is an historian with the Historical Division, Office of the Chief of Engineers. He has written one article on the subject of flood control on the Lower Mississippi and is preparing a book-length manuscript on the same subject. He holds a Ph.D. degree from Duke University.





## ACKNOWLEDGMENTS

A number of people have worked with me in developing this present volume, providing many helpful suggestions and considerably expediting completion of the work. Colonel John F. Hatch, Jr., Memphis District Engineer, enthusiastically supported the project from the beginning. Pat Flaherty and Ray Houston of the Memphis District helped coordinate the work so that no time was lost between manuscript and printed product. Dr. John Greenwood, Chief of the Historical Division, Office of the Chief of Engineers, reacted with typical aplomb when this project was unexpectedly dropped on his desk and offered his full support. He and Dr. Paul Walker, also of the Historical Division, read the introduction, and their recommendations proved of much help. Miss Mary Loughlin edited the introductory essay quickly and competently.

My wife Jane helped me in many ways. She wrote the first draft of the chronology, listened patiently to my expositions on the history of Memphis District, and tolerated my strange evening and weekend working hours while I was completing the volume. In the process she learned more about Memphis District than she could possibly have wanted to know. Now I've got myself in a fix; I guess I owe her at least one trip to Memphis.

Martin Reuss  
May 1982





## TABLE OF CONTENTS

|  |    |
|--|----|
| Introduction   | ix |
| Part I. FAMOUS MEMPHIS DISTRICT ENGINEERS  | 1  |
| Part II: REPRINTS  | 7  |
| Document 1. Report of the Board of Engineers on the<br>Ohio and Mississippi Rivers (1822)  | 9  |
| Document 2. Report of the Secretary of War Communi-<br>cating Reports in Reference to the Inundations of the<br>Mississippi River (1852)   | 27 |
| Document 3. Letter from Lieutenant Colonel William F.<br>Raynolds to Brigadier General Andrew A. Humphreys,<br>Chief of Engineers (St. Francis River, 1870)  | 39 |
| Document 4. An Act to Provide for the Appointment of a<br>“Mississippi River Commission” for the Improvement<br>of Said River from the Head of the Passes Near its<br>Mouth to its Headwaters (1879) | 47 |
| Document 5. <i>A Resumé of the Operations in the First and<br/>        Second Districts: Mississippi River Improvement,<br/>        1882-1901</i> (excerpt on Memphis Harbor, 1882-1892)             | 51 |
| Document 6. An Act for the Control of Floods on the<br>Mississippi River and its Tributaries, and for Other<br>Purposes (1928)   | 85 |
| Part III. CHRONOLOGY   | 93 |





## INTRODUCTION

*The Mississippi!* the geat big rollin', tumblin', bilin', endless and almost shoreless Mississippi! There's a river for you! . . . I tell you the United States is a great country! There ain't nobody but Uncle Sam as could afford such a river as that!

—Yankee Doodle, Esq. (pseudonym), 1844<sup>1</sup>

Army Engineers at Memphis have been fighting the “rollin', tumblin', bilin',” Mississippi for a hundred years. Today, the Army Engineer District at Memphis is responsible for navigation improvements and flood control work in an area lying approximately between the mouth of the White River to the south and Cairo, Illinois, to the north. The District's functions are many: constructing levees, drainage channels, floodgates, reservoirs, floodways, floodwalls, pumping stations, and harbors; protecting riverbanks; removing snags and other debris; dredging rivers to provide proper channel depth; furnishing floodplain information; administering environmental regulations; and operating and maintaining recreation sites. Yet, if the District's functions are difficult and varied, its long experience with the contentious Mississippi has prepared it well for its tasks. In fact, the story of the Army Engineers on the Mississippi begins only a few years after the 1803 Louisiana Purchase, when the United States acquired sole possession of the great river.

\* \* \* \* \*

It was the beginning of a new era. Steamboats came to the Mississippi in the second decade of the nineteenth century, luring the venturesome with promises of quick profits, but threatening the unlucky and unprepared with disastrous economic blows. Politicians from states along the Mississippi, led by congressman Henry Clay of Kentucky, campaigned to obtain federal appropriations to improve the navigability of both the Ohio and Mississippi rivers. Secretary of War John C. Calhoun shared their interest, although for a different reason. He concurred with the judgment of a special board of officers that national defense required good transportation facilities within the interior. The War of 1812, despite its successful conclusion, had made the young nation painfully aware of this.

Yet there was a question about the constitutionality of internal improvements funded through the federal treasury. Did the constitutional responsibility to regulate interstate commerce apply to the improvement of rivers or did that prerogative lie entirely with states and local communities? The question was not settled until 1824—and even then not entirely—when the Supreme Court ruled in *Gibbons v. Ogden* that the federal powers over

interstate commerce included riverine navigation “so far as that navigation may be in any manner connected with the commerce.” Until that decision, Congress had not been disposed to associate itself actively with river improvement. Initial congressional activity, consequently, was minimal; only Calhoun’s insistence that river improvement was also necessary for national defense moved some congressmen, reluctantly, to vote appropriations for surveys and investigations of the nation’s rivers.

In 1820, Congress appropriated \$5,000 for a survey of the Ohio and Mississippi rivers. As with other surveys, the Army Corps of Engineers was charged with its execution. At the time, Engineer officers—almost all graduates of the U.S. Military Academy, the country’s only engineering school—supplied much of the nation’s engineering talent. Congress specifically instructed the Corps to make the survey “for the purpose of facilitating and ascertaining the most practicable mode of improving the navigation” of the Mississippi and Ohio.<sup>2</sup> In October 1821, Brigadier General Simon Bernard and Brevet Lieutenant Colonel Joseph G. Totten, accompanied by two other Engineer officers, left Louisville, destined for New Orleans. Their journey did not start happily. The government steamboat *Western Engineer*, especially built for western river explorations and used earlier by Major Stephen H. Long, had broken down. Totten, Bernard, and the others were forced to pole down the Ohio on a keelboat.<sup>3</sup>

Bernard’s and Totten’s final report was unremarkable in its observations about the Mississippi. Its significance lies in being the first report on navigation problems along the entire lower Mississippi River. The two officers noted the many natural obstructions in the river, including trees fixed in the bed of the river or bunched together in river “rafts” in such a way as to hinder the passage of keelboats and flatboats which operated close to the banks. They speculated, not entirely accurately, that when levees were built along the entire Mississippi (or when the shoreline was deprived of any forest growth) these obstructions would disappear. Until that time the only thing to do was to remove the “snags,” a tedious and time-consuming process. In conclusion, the authors advised, “For the present, the security of navigation will depend . . . upon the kind of boats employed, upon the talents, the prudence, and the experience of the pilots, and upon the success of the attempts to diminish the number of snags.”<sup>4</sup> The report was submitted to Congress, which proceeded to bury it along with many others until the time seemed right for its resurrection.

That time was 1824. Shortly after the *Gibbons v. Ogden* decision, Congress passed the General Survey Act empowering the President to employ civil engineers and officers of the Corps of Engineers to make surveys, plans, and estimates for “the routes of such roads and canals as he may deem of national importance.” Less than a month later, on 24 May 1824, Congress passed another act “to improve the navigation of the Ohio and Mississippi Rivers,” in which the President was authorized “to take prompt and effectual measures” to remove all trees fixed in the bed of the two rivers and to buy whatever vessels and machinery he needed for that purpose. The General



Survey Act was repealed in 1838, but, by then, the Corps had become involved in river and harbor work throughout the nation. The second act committed the Army Engineers to improve navigation on the Mississippi and the Ohio rivers, and this responsibility the Corps has fulfilled to the present day.

The Corps employed Henry M. Shreve to clear the Mississippi. Already well-known as a designer of steamboats and steam engines, Shreve had been among the first to show the steamboat's economic potential on western rivers. In December 1826, Major General Alexander Macomb, the Chief Engineer, appointed Shreve Superintendent of Western River Improvements. Within a year Shreve designed a steam snagboat. The boat, the *Heliopolis*, was built by the Corps of Engineers and launched in 1829. It became the model for steam snagboats on the Mississippi and elsewhere. The accomplishments of these boats were impressive. In 1834 one Engineer officer was able to report that "the high-water navigation is rendered comparatively safe and easy. Boats run with security at night, where, a few years since, it was hazardous to attempt a passage even in daylight."<sup>5</sup> Insurance and shipping rates dropped, and the number of steamboats increased on the Mississippi. The snagboat became a permanent fixture of river improvement until the end of the steamboat era.

New Orleans was the principal destination of most steamboats on the Ohio and Mississippi. In 1834 there were 2,300 steamboat landings in the city's bustling harbor. That same year, Memphis, founded only 15 years before, established its first steamboat line—naturally, to New Orleans. In 1846, and again in the middle and late fifties, one line with two steamboats operated weekly runs between Memphis and Cincinnati. Beginning in the late 1850s, steamboats ran three times a week between Memphis and Louisville. An attempt to provide weekly service between Pittsburgh and Memphis failed in 1859 after only two months in operation. Still, Memphis, with a population of about 23,000 on the eve of the Civil War, had become a thriving riverboat town.<sup>6</sup>

The increasing river traffic predictably generated pleas for additional improvements on the Ohio and Mississippi. Navigation interests, joined by flood control proponents, assembled in so-called river conventions in the 1840s and 1850s. The federal government, speakers declared, must bear a greater burden for insuring the navigability of the two rivers; the cost was clearly too great to be borne by the states alone. Influential leaders along the Mississippi also contended that federal appropriations should pay for levees, which would provide flood protection as well as help navigation. At one of the most important river conventions, held in 1845 in Memphis, John C. Calhoun admonished Congress not to slight the Mississippi when appropriating funds for river improvement.

Responding to both public pressure and the suffering resulting from floods in 1849 and 1850, Congress passed, in those two years, two swamp land acts. These acts transferred "swamp and overflow land" to most of the states along the lower Mississippi on condition that the revenue the states obtained from selling the land be used to build levees and drainage channels.



Eventually, Missouri obtained 3.3 million acres and Arkansas received 7.7 million acres under the provisions of these acts. Kentucky and Tennessee, with higher ground than states further south in the Mississippi delta, received no land.<sup>7</sup> Funds obtained through the selling of swamplands enabled the citizens of the St. Francis basin in Arkansas to build small 3-foot levees in the 1850s, stretching from Commerce Hills to near the mouth of the St. Francis River. Although floods in 1858 and 1859 devastated those levees, the St. Francis levee system “marked the highest stage of Lower Mississippi levee development” seen to that time.<sup>8</sup> Many years passed before levees of this standard could be successfully maintained.

Congress also responded in another way to pleas from lower Mississippi politicians. In 1850 it appropriated \$50,000 for a topographic and hydrographic survey of the Mississippi delta, “with such investigations as may lead to determine the most practicable plan for securing it from inundation, and the best mode of so deepening the passes at the mouth of the river as to allow ships of twenty feet draft to enter the same.” Charles S. Ellet, Jr., one of the best-known American engineers of the day, applied to make the survey. The Secretary of War, Charles M. Conrad, agreed to use Ellet on a three-man team which included Lieutenant Colonel Stephen H. Long, already well-known for his river surveys, and Captain Andrew A. Humphreys. Both officers served with the Corps of Topographical Engineers, which had been separated from the Corps of Engineers in 1838 (the two Corps were permanently rejoined in 1863). The Secretary’s suggestion did not suit Ellet, however; consequently, Conrad allowed Ellet to work independently. Two reports were thus submitted to the Secretary of War.<sup>9</sup>

On behalf of Humphreys, who became quite ill and had to quit the survey, Long submitted a report which simply explained what surveying and hydrometric observations had been accomplished and what still needed to be done. Ellet’s report, therefore, became the first comprehensive study of flood control on the Mississippi. What distinguished the report was the author’s insistence on both the practicability and value of building reservoirs on the Mississippi’s tributaries to reduce flooding. Colonel John J. Abert, Chief of the Topographical Engineers, commented when forwarding Ellet’s plan to Conrad, “While I willingly admit that all the speculations of a man of intellect are full of interest, and deserving of careful thought, yet I cannot agree with him that these reservoirs would have any good or preventive effects upon the pernicious inundations of this river . . . .”<sup>10</sup>

Humphreys resumed his investigation of the Mississippi delta in 1857, this time with the assistance of Lieutenant Henry L. Abbot. Their voluminous *Report Upon the Physics and Hydraulics of the Mississippi River*, submitted in 1861, was awesome. Full of new data about the Mississippi, it also contained analyses of other rivers of the world. Earlier flood control plans were examined and usually found to be lacking. The authors introduced entirely new formulations to explain river flow and sediment resistance. They concluded that Ellet’s calculations and assumptions were erroneous. Their own position, based on significantly more information, was that “levees only”

could prevent flooding on the Mississippi. Neither reservoirs nor cutoffs were needed.<sup>11</sup> A hundred years later, two hydraulic engineers concluded that “Humphreys and Abbot developed a method for measuring and computing discharge that, but for its cumbersome form, could, with possible modifications, be used today.”<sup>12</sup> Already a member of the American Philosophical Society, Humphreys received numerous honors for his work on hydraulics. He was made a fellow of the American Academy of Arts and Sciences, was an original incorporator of the National Academy of Science, and received a doctor of laws degree from Harvard in 1868.

The Civil War halted any river improvement work. Union troops cut levees, and Confederate troops sank vessels to block the Mississippi. By the war’s conclusion, the Mississippi and its tributaries were more vulnerable to floods than at any time since before 1820. In December 1865, Secretary of War Edwin Stanton ordered Humphreys, by then a brevet major general, to inspect the Mississippi River levees and replace those that were vital to protect commerce or agricultural interests.<sup>13</sup> Humphreys managed to obtain Abbot, a brevet brigadier general at the time, for the work between Memphis and Vicksburg. Colonel Junius B. Wheeler, later a West Point professor, became Humphrey’s assistant on the levees from Vicksburg to New Orleans. None of the men, of course, doubted that rebuilding levees would, in accordance with the principles set down in the Humphreys-Abbot report, help prevent further flooding and provide a navigable channel.

Humphreys submitted his report to Stanton at the end of May 1866, only two months before he was appointed Chief of Engineers. He noted that the levees “may be considered as virtually destroyed” from a point on the Mississippi opposite Memphis to the mouth of the St. Francis River. However, he advised against federal assistance as he did not think his instructions covered this situation; repairing the levees in the St. Francis bottomland was not vital to either commerce or agricultural interests. Between the mouth of the St. Francis and the mouth of the Arkansas, planters were already repairing levees, and no federal assistance was required.<sup>14</sup>

Humphreys’ report was finished just after a flood had inundated the lower Mississippi; another flood came the following year. It is doubtful that federal assistance, even had it been authorized, would have been completed in time to control the 1867 flood. Congress did, however, agree to help the flood victims in both years. It authorized the Army, through the Freedmen’s Bureau, to distribute flood rations—one bushel of corn and eight pounds of pork per month per person, emergency fuel, temporary shelter, and medical care. Occasionally, the Bureau even issued seeds to flood victims to begin new crops.<sup>15</sup>

The Reconstruction Congress was willing to use the Freedmen’s Bureau to alleviate the suffering of blacks and poor white people, but it was not interested in initiating a policy that would permanently benefit private property owners along the lower Mississippi. Most congressmen still believed such a policy unconstitutional. The question of opening up the Mississippi to commerce was another matter. Channel obstructions hindered river traffic



going to New Orleans from northern as well as southern states. For this reason, if for no other, Congress paid greater heed to pleas for removal of natural and man-made obstacles in the Mississippi.

As early as 1866 Congress authorized the Secretary of the Navy to transfer to the Secretary of War portions of the Mississippi River fleet which could be used "without detriment to the public service" for raising snags and removing obstructions in the western rivers, including the Mississippi. The following year, \$200,000 was appropriated to improve the mouth of the Mississippi. Part of this appropriation was used to fund the construction of two dredge boats. In 1868 Congress appropriated another \$40,000 for Mississippi River improvements.<sup>16</sup> Throughout the 1870s periodic appropriations were made to improve and maintain the channels at the mouth of the Mississippi.

The Mississippi was hardly the only river bedeviled by snags and other obstructions. Many of its tributaries also were dotted with navigation hazards of all sorts. Soon after the conclusion of the Civil War, Army Engineers began to survey these rivers to ascertain the extent of danger to navigation and to recommend means to eliminate the obstacles. One of the rivers investigated was the St. Francis. In 1870, H. L. Koons, a civilian engineer working for the Corps, submitted a report in which he recommended snagging operations and the construction of wing dams on the St. Francis. His superior, Lieutenant Colonel William F. Reynolds, disagreed with Koons on the advisability of building wing dams "in a stream of little or no current." He did, however, agree that snags and fallen trees should be removed.<sup>17</sup> The following year Congress appropriated \$10,000 to improve the St. Francis.<sup>18</sup> Major Charles R. Suter, in charge of work on the Mississippi, Missouri, Arkansas, and White rivers, as well as the St. Francis, argued that an iron-hulled snagboat was absolutely essential for operations on the White and St. Francis rivers and ordered the construction of the Corps' first such boat, the *J. N. Macomb*. This boat, Suter reported, drew only 2 feet 6 inches of water, whereas a wooden boat of similar size would draw 3 feet 2 inches. On shallow streams such as the White and the St. Francis the difference would be significant. Moreover, the iron-hulled boat, while costing more initially, would last three times longer than a wooden one.<sup>19</sup>

The *J. N. Macomb* soon proved its worth on the Arkansas, Mississippi, and Missouri Rivers. However, its success became irrelevant for St. Francis basin residents. Congress refused to appropriate money for the St. Francis beyond the initial \$10,000 and snagging operations there stopped after only a few months of work.<sup>20</sup>

Lack of funding for the St. Francis was hardly typical of the times. Indeed, the period from 1866 to 1883 has been called the "golden age" of pork-barrel legislation.<sup>21</sup> During this period a river and harbors bill was passed every year but one. These bills significantly increased the volume of work for the Corps. The 1866 act called for over \$3.5 million for 49 projects and 26 surveys. In contrast, the 1882 act appropriated nearly \$19 million for 371 projects and 135 surveys.<sup>22</sup> Generally, the Mississippi benefited greatly

from this new enthusiasm for the pork-barrel. In 1874 Congress appropriated funds to conduct a new survey of the lower Mississippi from Cairo to New Orleans. Major Suter conducted the survey, providing new maps and a wealth of information. The same year Congress also authorized the President to establish a commission of three Army Engineers and two civilian engineers to study the best system for the “permanent reclamation and redemption” of the alluvial basin of the Mississippi River.<sup>23</sup> Chief of Engineers Humphreys created another board in 1878 to consider the means to improve low-water navigation of the Mississippi and Missouri rivers.<sup>24</sup> Both boards were eliminated upon the creation of the Mississippi River Commission (MRC) on 28 June 1879.<sup>25</sup>

Congress established the MRC to coordinate river improvement work on the Mississippi and to insure that both civilian and military advice was obtained on the subject. The seven-member board was to be chosen by the President of the United States and confirmed by the Senate. The commission president and two other members were selected from the Corps of Engineers. The United States Coast and Geodetic Survey provided another member. The remaining three members, two of whom had to be civil engineers, came from civilian life. Brevet Major General Quincy A. Gillmore became the first president of the commission, headquartered in St. Louis.

Among the duties Congress assigned to the MRC were to prepare plans to deepen the channel and protect the banks of the Mississippi; “improve and give safety and ease” to Mississippi navigation; prevent destructive floods; and promote and facilitate commerce, trade, and the postal service. Naturally, the immediate problems were to develop a plan of action and obtain the necessary equipment to implement the plan. In both areas commission members moved quickly. By the end of 1881 the commission had obtained 4 barges, 2 mattress barges, 30 pile drivers, 78 barges for the transportation of brush and stone; 2 large quarterboats, 5 towboats, 2 steam launches, portable quarters and mess rooms to accommodate 500 laborers, and equipment enough to supply 2 blacksmith shops and 2 carpenter shops. Also, by this time the MRC had come to the important conclusion that Humphreys and Abbot were essentially correct in recommending “levees only” to control floods along the Mississippi. Commission members rejected any suggestion of dispersing floods through controlled outlets. Rather, they recommended that all outlets “directly connected with the improvement and maintenance of navigation,” be permanently closed.<sup>26</sup>

The MRC decided to begin its program of river improvement at two points. One was the Lake Providence reach, between Louisiana and Mississippi just south of the Arkansas state line. The other was Plum Point reach, between Tennessee and Arkansas about 75 miles north of Memphis. Both reaches contained numerous shoals, and depths had been recorded as low as 4.5 feet. The commission proposed to build “training dikes” at both locations which would impede the flow of water, causing deposits to form in such a way that the current would be deflected into the desired channel. To complement that effort, the MRC decided to put willow brush mattresses



along the banks of both reaches to prevent bank caving and erosion.<sup>27</sup>

In neither area did the commission do much work before bitter cold and then a devastating flood struck the lower Mississippi basin in 1882. Actually, there were two floods, both in the month of February. The floods devastated local levee systems. There were 284 crevasses totaling 56 miles in length. The number of cold, hungry, and homeless people totaled in the thousands. Within one day Congress passed and the President signed a joint congressional resolution authorizing the Chief of Engineers to use the Corps' (not the MRC's) fleet of boats on the Mississippi to join in the rescue work, mainly to deliver vitally needed supplies. It was an historic occasion, for it initiated the Corps' work in the field of disaster assistance.<sup>28</sup>

The 1882 flood forced the MRC to concentrate more on levee construction. Proponents of flood control argued the necessity of greater federal involvement to prevent a recurrence of the 1882 tragedy. However, many congressmen steadfastly insisted that the federal government had no constitutional right to involve itself in flood control. Nevertheless, those in favor of flood control won an important victory in August 1882, when Congress approved a lengthy rivers and harbors bill (over a Presidential veto) which included an authorization for the MRC to repair and build levees "if in their judgment it should be done as a part of their plan to afford ease and safety to the navigation and commerce of the river and to deepen the channel." Not satisfied with that qualification, Congress also admonished, "that no portion of this appropriation shall be expended to repair or build levees for the purpose of reclaiming lands or preventing injury to lands by overflows."<sup>29</sup> This act also relieved the MRC from the responsibility of implementing its own plan. Instead, the Secretary of War was authorized to carry out the actual work. He, in turn, delegated this responsibility to the Chief of Engineers.

It was at the recommendation of Robert T. Lincoln, the Secretary of War, and Brigadier General Horatio G. Wright, the Chief of Engineers, that the MRC divided the river below Cairo into four administrative districts, each one to be supervised by the Corps of Engineers officer. Captain John G. D. Knight, in Cairo, was put in charge of the First District, stretching some 220 miles from Cairo to the foot of Island No. 40. The Second District, extending from Island No. 40 about 180 miles to the mouth of the White River, was the responsibility of Captain A. M. Miller in Memphis. The remainder of the river was divided between the Third District, with its headquarters in Vicksburg, and the Fourth District, operating out of New Orleans.<sup>30</sup> Essentially, the new system called for the MRC to initiate plans and submit them to the Secretary of War through the Chief of Engineers, who could only suggest modifications to the commission plans. This arrangement lasted until 1928, when Congress directed the MRC to adopt the Chief of Engineers Mississippi River flood control plan.

The MRC's reorganized administration suffered normal growing pains. For a while Captain Miller served concurrently as officer in charge of both the Second and Third Districts. During that time (1882-1884), he established the Third District headquarters in Memphis. In 1885, the First

District was moved from Cairo to Memphis. Captain Smith S. Leach became the officer in charge of both the First and Second Districts, although the District organizations under him retained their separate identities. This situation changed in 1890, when the officer in command at Memphis became known as the District Engineer for the First and Second MRC Districts. It was not until 1928 that the MRC Districts were abolished and replaced with the U.S. Army Engineer Districts at New Orleans, Vicksburg, and Memphis. Nonetheless, the Army Corps of Engineers correctly dates its continuous presence in Memphis back to 1882.

In the 1882 Rivers and Harbors Act, Congress appropriated \$4 million for improvements on the Mississippi, including Memphis harbor. Soon after passage of the act, the MRC also decided to improve the reach of river just above Memphis. The congressional appropriation and the commission's decision no doubt delighted Memphis residents, for work on the harbor and on Memphis reach was desperately needed. The Memphis waterfront had suffered severe bank caving and erosion problems since the mid-1870s. The disintegration of the bluffs threatened stores all along the river. The problem was compounded by the fact that the Mississippi carried sediment from Hopefield Point in the Memphis reach and deposited it in the harbor, consequently impeding river traffic; today's Mud Island at the Memphis waterfront resulted from just this action. Of course, the ultimate fear was that the river would undermine, figuratively and literally, Memphis' reason for existence—to serve Mississippi commerce.<sup>31</sup>

Another catastrophic flood in 1884 delayed work at Memphis. The water crested almost to the point it had reached two years earlier. As in 1882, the Corps of Engineers used its boats and equipment for emergency work (joined by Clara Barton and the American Red Cross in that organization's first flood fight). The flood destroyed revetment work at Memphis harbor, once more raising concern among the shopkeepers and other commercial interests. Congress, responding as much to the potential loss of government property at the waterfront as to the plight of Memphis merchants, appropriated \$200,000 specifically for work on Memphis harbor. This insured continued efforts to preserve the city's harbor and waterfront facilities.<sup>32</sup>

Despite attempts to develop and implement long-range plans, the MRC found itself often reacting to immediate problems, financial as well as natural. It was clear, for instance, by the mid-1880s that levee grades needed to be raised. However, the extent to which levees were heightened, or simply restored, more accurately reflected congressional funding levels than commission planning; and in the 1880s Congress was becoming increasingly frugal in its rivers and harbors appropriations. Yet, when still another disastrous flood hit the lower Mississippi in 1890, levees were in far better condition than they had been for some time. There had been 284 crevasses in 1882 and 204 in 1884; there were only 23 in 1890. Once again, Army Engineers performed rescue and relief work. They supervised hired laborers, who raised levees and plugged gaps and crevasses wherever possible. Flood stage on the Cairo gage was generally considered to be anything above 40 feet; for 71 days



the water exceeded this height, reaching a high mark of almost 49 feet on 12 March. Army Engineers working for the MRC became more convinced than ever that the construction and raising of levees to protect against flooding deserved as much attention as the low-water problems which affected navigation.<sup>33</sup>

The MRC set the 1890 flood flow line as the reference line for levee grades. In 1892 the commission allocated funds for levee construction in the lower St. Francis basin, thereby adopting a policy of protecting this front. After the Arkansas General Assembly incorporated the St. Francis Levee District in 1893, Congress appropriated \$75,000 to construct a levee from Kents Mound to Wheel Ridge in Lee County, a distance of 6 miles, to prevent the Mississippi from cutting through to the St. Francis at Walnut Bend. By 1896 the MRC and state and local interests had built 120 miles of levees in the St. Francis Levee District, stretching from just above Point Pleasant, Missouri, to Pecan Point, Arkansas. Meanwhile, the commission had also built all but 6 of the 66 miles of levees in the White River Levee District. By 1896 this levee line stretched continuously from Helena, Arkansas, to Scrub Grass Bend, just above the mouth of the White River.<sup>34</sup>

While the MRC had become preoccupied with problems of high water, commercial interests along the Mississippi continued to worry about low-water navigation. In November 1891, representatives of steamboat transportation lines operating below St. Louis appeared before the commission to plead for immediate relief from low-water. After a thorough investigation, the commission decided that dredging was the only means to provide relief quickly. It authorized construction of an experimental hydraulic dredge, later named the *Alpha*. This dredge proved its worth in its first test at Cape Girardeau, Missouri. In eight days it cleared an 1,800-foot bar and, where there had been only 3 to 4 feet of water, provided a 6-foot channel. Most encouraging, the channel remained clear the entire season. Convinced of the benefits of dredging, the commission authorized construction of a second dredge, the *Beta*. Completed in January 1896, this boat was far more sophisticated than the *Alpha*. Its major advantage was that it had two, rather than one, pumping units. Once their effectiveness was demonstrated, hydraulic dredges became an integral part of the commission's plans for river improvement. In 1896 Congress not only first authorized, but required, the construction of dredges "with the view of ultimately obtaining and maintaining a navigable channel from Cairo down, not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year except when navigation is closed by ice."<sup>35</sup> In response, the MRC established a Dredging District at St. Louis. The District's plant and equipment were later transferred to West Memphis, Arkansas, but its operations remained independent until incorporated into Memphis District in 1928.

Another major flood occurred in 1897. Most of Mississippi, Poinsett, St. Francis, Cross, Crittenden, and Lee counties in Arkansas were covered with water. Several people drowned on President's Island south of Memphis, where the water was from 1 to 5 feet deep. Within the present boundaries of

Memphis District, nearly 50 towns were inundated and about 60,000 people suffered property damage. No precise number is available on the number of deaths, but it has been estimated at 70. Working with the levee boards, the Engineers raised levees, using mule-drawn scrapers to pile earth on top of the levees. All these efforts were futile, however, as the 1897 flood crested from 3.5 to 4.5 feet higher than the flood of 1890. Near Caruthersville, Missouri, armed men deliberately breached a levee, presumably to save their own lands from flooding, and 14 crevasses developed.<sup>36</sup>

Captain Graham W. Fitch, First and Second MRC Districts Engineer, led the flood fight between Cairo and the mouth of the White River. He placed an assistant in direct charge of each levee section and sent the MRC towboat *Titan* and other boats up and down the Mississippi to leave lumber and sandbags wherever those supplies were needed. The boats doubled as rescue stations for the sick and homeless. Fitch also sent the steamer *Itasca* downstream on a rescue expedition. The crew of this vessel managed to save 177 people, 95 horses and mules, 173 cattle, 82 hogs, and a large amount of household goods. Meanwhile, John A. Ockerson, the senior engineer for the MRC, dispatched the steamers *Minnetonka* and *Vidalia* from St. Louis to rescue people between New Madrid and Memphis. The two steamers rescued 145 people in 7 days. The crew of the *Abbot*, a small survey boat out of Memphis, managed to save another 63 people.<sup>37</sup>

The 1897 flood spurred efforts to construct more levees. By 1904 the MRC had spent about \$57 million on 1,500 miles of levees. In that year, workers completed the St. Francis levee system.<sup>38</sup> Work continued throughout the lower Mississippi valley, but not fast enough to prevent the catastrophes of 1912 and 1913.

The 1912 flood brought into question the continued reliance on levees. For 60 days the Mississippi was at flood stage. At most places below Cairo previous flood crest levels were broken. Where they were not, it was only because the levees had failed before the water crested. The high-water mark at Memphis was 45.3 feet, a new record. Crevasses occurred at Hickman, Kentucky; Caruthersville, Missouri; and in two locations on the St. Francis levee. Backwater from Bayou Gayoso, Cypress Creek, and Nonconnah Creek crept into the residential and industrial areas of Memphis. The first stories of many commercial buildings were under water. The city's water supply and gas plants were both put out of operation. In all, the flood damaged 714 houses and 25 manufacturing plants in Memphis.<sup>39</sup>

Major Clarke S. Smith supervised the flood fight in the First and Second Districts. He worked—often futilely—with local levee districts to raise levees. The MRC employed 350 men and supplied 50,000 sacks to be used for sandbags to help the Reelfoot Levee District hold its levees. Although the sandbags appeared to be holding back the water, a windstorm drove waves over the bags, eventually washing them out. The water destroyed about a mile of levee. Sandbags were also placed on levees in the St. Francis and White River Levee Districts. In both areas the sandbags held until record river heights caused crevasses. Altogether, more than 49,000 feet of levees were



destroyed in the First and Second MRC Districts. Smith estimated that the flood had caused about \$3 million worth of damage.<sup>40</sup>

Levee repair had scarcely begun when another flood caused havoc the following year. In 1913 the river crested twice, once in January and then again in April. Major Edward M. Markham (later a Chief of Engineers) of the First and Second MRC Districts attempted to raise levees sufficiently high to protect the land from a 46-foot flood stage. However, extra exertion and early planning all seemed to no avail. Breaks again occurred in levee lines all along the river. Once more Memphis suffered damage. Water flooded some 20 blocks and drove over a thousand families from their homes. At Markham's request, the Army Quartermaster Corps sent tents to Memphis, Hickman, Caruthersville, and Helena. The Quartermaster Corps also sent boats downstream loaded with rations and forage. As in the previous year, the Engineer fleet was used to perform rescue and relief work.<sup>41</sup>

The 1912-13 floods raised great concern about the effectiveness of the levee program. Congress held hearings, and experts submitted various plans, many directly conflicting with others. Indeed, the lengthy testimony and complicated technical plans seemed to confuse Congress. Moreover, there were still some congressmen who doubted whether the federal government should involve itself in flood control no matter how extensive the suffering. Consequently, little progress was made toward an effective flood control program.

The mood of Congress changed, however, after the 1916 flood. This flood broke all previous records on the Vicksburg gage and generated interest throughout the nation in flood control legislation. Once more the Quartermaster Corps and the Corps of Engineers engaged in massive flood-fight, rescue, and relief operations. More hearings were held by Congress. Finally, on 1 March 1917, Congress passed its first flood control bill. The measure authorized \$45 million for flood prevention between the mouth of the Mississippi and the mouth of the Ohio; no more than \$10 million was to be spent in any one year. Essentially, this money allowed the MRC to expedite the implementation of plans it already had approved. No new flood control plans were authorized. The act stipulated that local interests must contribute at least one half of the cost for the construction and repair of levees and also must provide rights-of-way free.<sup>42</sup> The important point, however, was that Congress was now committed to flood control on the lower Mississippi.

Flood control is not flood prevention; man's control over nature is hardly so great that he can relax his vigilance. His main hope is to confine and guide the water once high flows begin. In 1922 another flood occurred. Below the mouth of the White River, the Mississippi hit record stages. Flooding was less severe in the First and Second Districts, but, even so, backwater flooded more than 1.4 million acres of land. Most of the damage occurred in the St. Francis backwater area. For the first time, the American Red Cross assumed almost all of the relief operations. The Corps was able to devote most of its energy to raising and repairing levees.<sup>43</sup>

Once more the "levees only" policy was examined. More engineers

expressed their doubts; confining the water appeared unworkable in itself. Engineers and politicians argued about reversing policy; perhaps the water should be dispersed over selected areas where the least damage would be done. Human nature being what it is, the selected area was always another's land, not your own.

Then came the flood of 1927. On 1 April 1927 the MRC advised Major General Edgar Jadwin, the Chief of Engineers, that the "worst flood conditions ever known on the Mississippi River" were expected.<sup>44</sup> The commission's forecast proved accurate. The flood came in three waves, in January, February, and—the one people remember—April. Many levees under the jurisdiction of the MRC gave way. On 15 April a major crevasse occurred at Whitehall, Arkansas. It grew to a length of 1,250 feet. Water flooded 80,000 acres and left 8,500 people homeless. The following day another crevasse happened at Dorena, Missouri. There, 135,000 acres were flooded and 7,500 people left homeless. Three days later the water overtopped a ridge levee stretching between New Madrid and Farrenburg, Missouri; the water inside New Madrid was 15 feet higher than the Mississippi in front of the town. Army Engineers blasted the levee at the southern end of St. John Levee District, allowing the water in New Madrid to return to the Mississippi. Levees in the St. Francis District were blown up by "unidentified" parties, probably farmers trying to prevent flooding on their own land. Steady rain soaked the still unfinished levee at Knowlton, Arkansas. The water finally had its way as it created a crevasse and flooded 100,000 acres, caused 19 deaths, and left thousands in temporary shelters. Many other levee breaks occurred; some of the most devastating were further south on the Mississippi.<sup>45</sup>

Major Donald H. Connolly, District Engineer in the First and Second Districts, committed all of his men and equipment to the flood fight. The Corps' efforts undoubtedly prevented many tragedies, but the flood was huge. Connolly and his personnel could only reduce the suffering, not eliminate it. Between Cairo and Columbus, Kentucky, the river crested about 1.7 feet above previous records. From Columbus to Memphis, the crest was actually a foot less than the 1913 reading. Further south, however, the story was different. From Memphis to New Orleans, the 1927 flood surpassed all previous records by 1 to 4 feet.<sup>46</sup>

The 1927 flood took between 250 and 500 lives in the lower Mississippi valley. It flooded over 16 million acres and forced over a half-million people from their homes. Over 25,000 buildings, both commercial and residential, were destroyed or damaged. The MRC estimated that total property damage amounted to \$236 million. The widespread suffering generated a relief expedition, including the first use of radios and airplanes in a rescue operation, unlike any in the history of the country. State and federal governments, the American Red Cross, and other organizations all participated. The flood took both a physical and psychological toll. Few born since World War II can imagine the scene awaiting the survivors of the 1927 disaster. Clarendon, Arkansas, provides a typical case. "The stench in Clarendon is unbearable," reported the Memphis *Commercial Appeal*. "Mud



and slime fill streets. A carload of lime for disinfecting purposes is to arrive tomorrow. The spirit of the people, which has been good until today, suffered a noticeable let down as the full extent of their calamity dawned upon them. Some of the residences have been cleaned out and the wrecked furniture thrown into the streets.”<sup>47</sup>

Clearly, something had to be done. Both Jadwin and the MRC submitted reports to Congress recommending ways to prevent future disasters of this magnitude. Principally because Jadwin promised equal protection for less than half the money, Congress accepted his plan. On 15 May 1928 Congress approved “An Act for the control of floods on the Mississippi River and its tributaries, and for other purposes.” This legislation established what has come to be popularly known as the Mississippi River and Tributaries project. In it Congress instructed the MRC to carry out Jadwin’s plan “under the direction of the Secretary of War and supervision of the Chief of Engineers.”<sup>48</sup> The Corps became both the planner and implementer of flood control on the lower Mississippi. Symbolizing this new role, the MRC Districts were renamed. The numerical designations were eliminated, and each District took the name of its headquarters city. The First and Second Districts, plus the Dredging District, became Memphis District. The area of the District, nearly 200,000 square miles, was much larger than it is today. In 1928 it included the entire drainage basins of the Arkansas and White rivers and extended into the states of Colorado, New Mexico, Texas, Oklahoma, and Kansas. The Third District became Vicksburg District. The old MRC Fourth District’s duties were assumed by the Second New Orleans District. Also, the Districts were placed in a new Corps of Engineers Division—the Lower Mississippi Valley Division. The officer in charge of that Division also became the President of the MRC. He reported to the Chief of Engineers.

The 1927 flood demonstrated the bankruptcy of the “levees only” policy. In addition to levees, Jadwin proposed a mix of floodways and spillways. The plan called for sending about half of the Mississippi’s flood waters down the Atchafalaya River in southwest Louisiana into the Gulf of Mexico. This was an idea which Humphreys and Abbot had deemed “virtually impracticable,” but the Atchafalaya had greatly enlarged over the years so that most engineers now considered the proposal workable. On the other hand, Jadwin stood firmly in the tradition of his predecessors in his opposition to reservoirs. He had established a special Reservoir Board of Engineer officers to examine the subject, and the board had concluded that Jadwin’s plan was “far cheaper than any method the board has been able to devise for accomplishing the same result by any combination of reservoirs.”<sup>49</sup>

Opposing reservoir construction became an increasingly unpopular position during the Great Depression which began in 1929. Public works projects, once considered uneconomical, began to look very attractive as a means of employment. Moreover, many politicians felt that reservoirs for flood control were essential to protect human life no matter what their cost. Reacting to this political interest, the Corps reversed its position on a number of projects that it formerly had judged not cost-effective. Revised reports

concluded that the necessity for “public-work relief” and the suffering caused by recurring floods provided grounds for construction. The reports for both the Yazoo River in Mississippi and the St. Francis River in Arkansas and Missouri were revised in this fashion, and Congress authorized reservoir construction on those two rivers in the Overton Act of June 1936.<sup>50</sup>

In January 1937, before Memphis District could even get its plans for the St. Francis off the drawing board, it had to gird itself for another flood fight. The flood first struck the Ohio River, but inevitably the water poured into the Mississippi. “A super flood is on the way,” proclaimed Colonel Eugene Reybold, Memphis District Engineer. “Water will surge almost ten feet above any recorded stage. There will be fifty-five feet in Memphis before the water now in sight from the Ohio moves out.”<sup>51</sup> Reybold prepared the District as best he could. He had the levee and floodwall at Cairo raised with sandbags and mudboxes. On his orders levees were also raised all along the Mississippi River in Memphis District. The idea was to protect the area against the predicted 61-foot flood crest. The crest, however, climbed to 62 feet on the Cairo gage.<sup>52</sup>

Reybold got Civilian Conservation Corps personnel and arranged for rescue and relief work by the Army, Coast Guard, and Red Cross. The assistance of these agencies allowed Reybold to pull the dredge *Potter* and steamers *Jupiter*, *Minnesota*, and *Nolty* off of rescue work and use them to save the levees. Reybold had his biggest problem at the Birds Point-New Madrid Floodway, one of the projects authorized in the 1928 Mississippi River and Tributaries Act. The Corps had purchased flowage rights and constructed a fuseplug levee. By blowing the levee, the Engineers would allow the Mississippi floodwaters to disperse into the floodway, thereby relieving the danger to Cairo. Reybold ordered the floodway to be evacuated, but the Corps had not acquired all the necessary flowage easements. Some people refused to leave. Men armed with shotguns gathered at the fuseplug. They were going to repulse any Engineer who dared show his head. The situation became more and more serious. The problem was eventually communicated to the Secretary of War, Harry Woodring, who asked Missouri’s governor, Lloyd C. Stark, to clear the armed men from the fuseplug area. “Time is a vital factor,” wrote Woodring, “and the levee must be blown within a very few hours or heavy loss of life is almost certain to follow.”<sup>53</sup>

Governor Stark complied with the Secretary of War’s request. State police and National Guard units cleared the levee, and on 25 January the Corps began dynamiting the fuseplug. Blasting stopped temporarily at the request of the governor to allow completion of the evacuation. However, by late evening of 26 January the river was moving through the floodway. Eventually the floodway accommodated about a quarter of the total flow past Cairo.<sup>54</sup>

Even though the 1937 flood surpassed the one 10 years earlier, Memphis District held the mainline levees successfully, with flooding only in the backwater areas and along tributary streams. Major Reybold, who became the Chief of Engineers during World War II, later asserted that his



military training “and similar training of countless Engineer officers sent to my assistance had a lot to do with the safe passage of the greatest flood the lower Mississippi Valley ever experienced.”<sup>55</sup>

The 1936 Overton Act initiated a period of intensive construction in Memphis District which was only temporarily delayed during World War II. In addition to the Overton Act, however, Congress also passed a flood control act in 1936 that authorized the construction of scores of projects, many of which would be Memphis District’s responsibility. The amount of work was so great that efficient operation was impossible from one District office. In 1937 the Chief of Engineers created the Southwest Division, which included the Arkansas River and tributaries above Pine Bluff and the White River and tributaries above Peach Orchard Bluff. These areas came to be served by the Little Rock, Albuquerque, and Tulsa Districts in the Southwest Division.

The St. Francis River project, authorized in the Overton Act, included not only a dam and reservoir, but also leveed floodways, a siphon, and channel improvements on the Tyronza River. At the head of the St. Francis, Wappapello Dam, begun in 1938 and completed in 1941, provided a storage capacity for 625,000 acre feet of water. After World War II, the land around the reservoir was transformed into a recreational area. Hunting, fishing, and boating are enjoyed by nearly a million visitors a year. The Marked Tree Siphon, located near Marked Tree, Arkansas, is another important feature of the St. Francis project. It carries excess water over a levee and into the St. Francis River.

The 1937 Flood Control Act authorized a project to protect Memphis from water rising over the banks of Wolf River and Nonconnah Creek. The Corps built floodwalls, levees, reservoirs, and pumping stations. The project gave the northern and southern ends of the city protection against a flood crest registering 54.5 feet on the Beale Street gage.

Other projects followed after World War II. The 1946 Flood Control Act authorized a \$17 million harbor project for Memphis. This included the closing of Tennessee Chute with a dam. Tennessee Chute was a branch of the Mississippi which swung eastward around President’s Island. By closing the Chute on the north, the Corps was able to create a slackwater harbor. The project was not completed until 1967. It included a 6,800-foot earth dam and a 12-foot deep and 300-foot wide channel. The project also provided for future development of recreational facilities and an industrial park.

Memphis District has also been involved in smaller harbor projects. The 1960 Rivers and Harbors Act gave the Chief of Engineers discretionary authority, within certain financial constraints, to approve small river and harbor projects not specifically authorized by Congress. Based on this legislation, the Corps has worked with local authorities to improve the harbors at Helena, Arkansas; Hickman, Kentucky; New Madrid, Missouri; and Osceola, Arkansas.

The 1950 Flood Control Act authorized three important projects in Memphis District: to enlarge and improve the Cache River in Arkansas; to construct an earth levee, pumping station, floodgate, diversion ditches, and to

relocate sewage facilities at Des Arc, Arkansas; and to protect the St. Francis backwater area. The District has also worked on flood control projects at Dyersburg and Huntington, Tennessee; Treasure Island and Drinkwater Sewer, Missouri; Hickman, Kentucky; Helena, Arkansas; and on the lower White River, Reelfoot Lake, and the West Tennessee and West Kentucky tributaries.

Memphis District has also been active during flood fights. There have been several dangerous floods in the post-World War II period—in 1950, 1973, 1975, and 1979. In 1973, the Mississippi was out of its banks for 62 consecutive days, a new record. During that flood fight, most flood control structures performed very well in Memphis District, although a few private ones did fail. The MRC estimated that flood control measures prevented damages in the lower Mississippi valley totaling more than \$7.2 billion during the 1973 flood. More than half of that savings was realized in Louisiana. Nevertheless, over \$560 million in property damage was prevented in the states of Arkansas, Tennessee, and Kentucky. Of course, the flooding caused serious problems, particularly for farmers. Nevertheless, people along the Mississippi seemed to take the flood in stride. “You’ve got to smile,” said Sheriff Lewis Gitchell, greeting evacuees from Ashport, Tennessee. “You can’t cry, because you might raise the water.”<sup>56</sup>

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The Mississippi rises and falls. It rarely behaves in accordance with man’s wishes. Rather, the river—still young in geological terms—like a child will continue to test man as it seeks new channels and erupts in periodic rages. Its history is often told in terms of its cataclysms; sometimes in terms of its romance. No matter how the history is related, few would deny the importance of the Mississippi to the development of this country, and especially to the cities along its banks.

The Army Corps of Engineers has been part of the history of the Mississippi. Its presence goes back over 150 years, and for more than a century it has worked to insure the navigability of that “Old Devil River.” At the same time, the Corps is responsible for controlling the rampaging floods. Nature, of course, has the advantage. Engineers may lessen the effects of natural calamities, but nature inevitably shapes the environment to its specifications, not man’s. Thus, the men and women of the U.S. Army Corps of Engineers face the challenge of reconciling nature’s laws with man’s desires. Most probably, the task will continue for a very long time. Most assuredly, the Corps will continue its long tradition of service to the people of Memphis District.



## NOTES

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37. Johnson, "Emergency Response," pp. 66-67.
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39. Johnson, "Emergency Response," p. 108; Williams, "Into the Second Century," p. 11.
40. Ibid.
41. Williams, "Into the Second Century," p. 12; Johnson, "Emergency Response," pp. 129-30.
42. *Laws of the United States Relating to the Improvement of Rivers and Harbors*, 3:1703-04. The 1917 Flood Control Act also provided \$5.6 million for the improvement of the Sacramento River.
43. Johnson, "Emergency Response," pp. 177-80; Clay, *A Century on the Mississippi*, p. 75.
44. Jadwin to the Secretary of War, 16 April 1927, Box 2417, Dec. 400.38, Adjutant General's Office, Central Files, Record Group 407, National Archives, Washington, as cited in Johnson, "Emergency Response," p. 187.
45. Clay, *A Century on the Mississippi*, pp. 88-90.
46. Johnson, "Emergency Response," p. 188.
47. *Memphis Commercial Appeal*, 6 May 1927, as cited in Pete Daniel, *Deep'n as it Come: The 1927 Mississippi River Flood* (New York: Oxford University Press, 1977), p. 129.
48. See Document 6, Reprints, this book.
49. "Report on the Control of Floods of the Mississippi River by Means of Reservoirs," House Flood Control Committee Document No. 2, 70th Congress, 1st Session, p. 33; See also Martin Reuss, "The Army Corps of Engineers and Flood Control Politics on the Lower Mississippi," *Louisiana History*, 23, 2 (Spring 1982): 131-48.
50. Reuss, "The Army Corps of Engineers and Flood Control Politics," pp. 140-44; *Laws of the United States Relating to the Improvement of Rivers and Harbors*, 3:2392-93, act approved 15 June 1936.
51. Reybold to Chief of Engineers, 25 January 1937, File 7402, Box 378, Office of the Chief of Engineers, Civil Works, 1923-1942, Record Group 77, Washington National Records Center, Suitland, Maryland, as cited in Johnson, "Emergency Response," p. 224.
52. Johnson, "Emergency Response," p. 225.
53. Woodring to Stark, 24 January 1937, Box 2407, Dec. 400.38, Adjutant General's Office, Central Files, Record Group 407, National Archives, as cited in Johnson, "Emergency Response," p. 226.
54. Johnson, "Emergency Response," p. 227.
55. Reybold to Lieutenant General Lewis A. Pick, Chief of Engineers, 22 December 1949, in *The Chief of Engineers' Memorandum to the Secretary of Army on the Hoover Commission Proposal*, pp. 1-6, as cited in Johnson, "Emergency Response," p. 228.
56. Information on post-World War II Memphis projects and flood fights was obtained from Williams, "Into the Second Century," pp. 17-28; Clay, *A Century on the Mississippi*, pp. 158-61, 188; the reports of Memphis District and the Mississippi River Commission in *ARCE*, 1980; and United States Army Corps of Engineers, *Floods and Flood Control on the Mississippi*, 1973 (Washington, D.C.: Government Printing Office, 1973).

## **Part I**

# **FAMOUS MEMPHIS DISTRICT ENGINEERS**





**WILLIAM T. ROSSELL (1849-1919)**

District Engineer, First and Second MRC  
Districts, 1888

Engineer Commissioner, Washington, D.C.,  
1892-1893

In charge of river and harbor works and  
fortifications, Alabama and Mississippi,  
1895-1901

In charge of improvements of Ohio River,  
1906-1909

Division Engineer, Eastern Division, 1909-1913

Brigadier General and Chief of Engineers,  
1913



**MASON M. PATRICK (1863-1942)**

District Engineer, First and Second MRC  
District, 1897-1898

Chief Engineer, Army of Cuban Pacification,  
1907-1909

District Engineer, Norfolk, 1909-1912

District Engineer, Detroit, 1912-1916

Chief Engineer, Lines of Communication  
(title later changed to Director of Con-  
struction and Forestry), France, 1917-1918

Chief of Air Service, American Expeditionary  
Force, 1918-1919

Division Engineer, Gulf Division, 1919

Commandant of the Engineer School and  
Post, Camp Humphreys, Virginia, 1921

Chief of the Air Service, U.S. Army, 1921-1927



**EDWARD M. MARKHAM (1877-1950)**

District Engineer, First and Second MRC  
District, 1912-1916

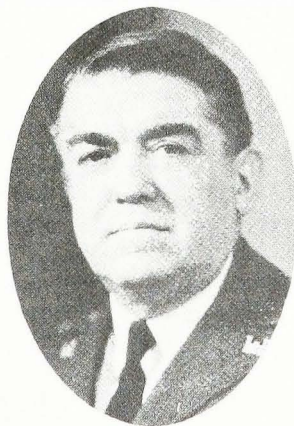
Deputy Director of Light Railways and  
Roads, Army Expeditionary Force, Europe,  
1918

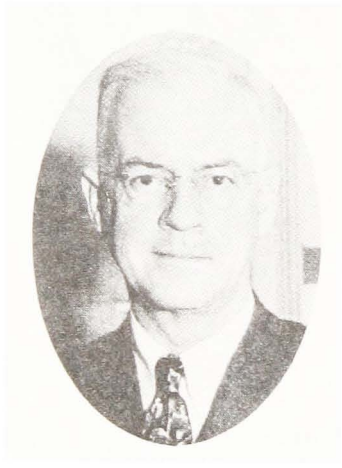
District Engineer, Detroit, 1919-1925

Commandant of the Engineer School and  
Post, Camp Humphreys, Virginia, 1925-1929

Division Engineer, Great Lakes, 1929-1933

Chief of Engineers, 1933-1937





**DONALD H. CONNOLLY (1886-1969)**

District Engineer, First and Second MRC District, 1923-1928

Director, Civil Works Administration, city of Los Angeles, 1934

Director, Chicago River and Harbor District, 1934-1935

In charge of Works Progress Administration (WPA) projects, Southern California, 1935-1939

Administrator, civil aeronautics, Department of Commerce, 1940-1941

Commanding General, Persian Gulf Command, 1942-1944

Director, Baltimore Department of Aviation, 1948-1956

**FRANCES B. WILBY (1883-1965)**

District Engineer, Memphis, 1928-1931

Chairman, Federal Board of Surveys and Maps, 1931-1935

Division Engineer, Gulf of Mexico Division, 1935-1938

Division Engineer, North Atlantic Division, 1938-1939

Chief of Staff, 1st U.S. Army, 1939-1941

Superintendent, United States Military Academy, 1941-1945

Commanding General, Fort Belvoir, Virginia, 1945-1946

Chairman, New York State Power Authority, 1946-1950



**EUGENE REYBOLD (1884-1961)**

**District Engineer, Memphis, 1935-1937**

**Division Engineer, Southwest Division,  
1937-1940**

**Assistant Chief of Staff, G-4 (Supply Division), War Department General Staff,  
1940-1941**

**Chief of Engineers, 1941-1945**



**DANIEL NOCE (1894-1976)**

**District Engineer, Memphis, 1937-1940**

**Commanding Officer, Engineer Amphibian  
Command, 1942-1943**

**Assistant Chief of Staff, G-3, European  
Theater of Operations, 1943-1944**

**Assistant Chief of Staff, G-3, Allied Force  
Headquarters, North African Theater of  
Operations, 1944-1945**

**Director of Plans and Operations, Head-  
quarters, Army Service Forces, War  
Department, 1945**

**Chief of Staff and Deputy Commanding  
General, Army Service Forces, War  
Department, 1946**

**Chief, Civil Affairs Division, War Depart-  
ment Special Staff (later redesignated Civil  
Affairs Division, Department of the Army),  
1946-1948**

**Deputy Director of Logistics, Department  
of the Army, 1948-1949**

**Chief of Staff, Headquarters, European  
Command, 1949-1952**

**Inspector General, Department of the Army,  
1952-1954**



**BREHON B. SOMERVELL (1892-1955)**

District Engineer, Memphis, 1931-1933

In charge of WPA projects, New York City,  
1936-1940

Director, Construction Division, Quarter-  
master Corps, 1940-1941

Assistant Chief of Staff, G-4, in charge of  
Supply, War Department General Staff,  
1941-1942

Commanding General, Services of Supply  
(renamed Army Service Forces in 1943),  
War Department General Staff, 1942-1946



**WILLIAM M. HOGE (1894-1979)**

District Engineer, Memphis, 1933-1935)

Division Engineer, Phillipine Islands, and  
Commander, 14 Engineer Regiment,  
1935-1937

District Engineer, Omaha, 1938-1940

Commanding Officer, Alaskan Canadian  
military highway (ALCAN Highway)  
construction, 1942

Commanding General, 5th and 6th Engineer  
Special Brigades, 1943-1944

Commander, Combat Command B, 9th  
Armored Division, 1944-1945

Commanding General, 4th Armored Divi-  
sion, 1945

Commanding General, Fort Belvoir, Virginia,  
1946-1948

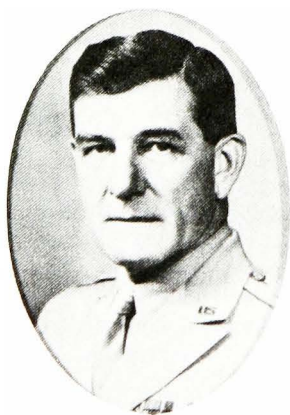
Commanding General, U.S. troops in Trieste,  
Italy, 1948-1951

Commanding General, 9th Corps, Korea,  
1951

Commanding General, 4th U.S. Army,  
1952-1953

Commanding General, 7th U.S. Army,  
Europe, 1953

Commander in Chief, United States Army,  
Europe, 1953-1955



## **Part II**

# **REPRINTS**





## **Document 1**

**REPORT OF THE BOARD OF ENGINEERS  
ON THE  
OHIO AND MISSISSIPPI RIVERS  
FROM AN EXAMINATION MADE IN THE MONTHS OF  
SEPTEMBER, OCTOBER, NOVEMBER, AND DECEMBER 1821\***

by

**Brigadier General Simon Bernard  
and  
Brevet Lieutenant Colonel Joseph G. Totten  
Corps of Engineers**

December 22, 1822

House Document Number 35, 17th Congress, 2d Session  
Reprinted from House Flood Control Committee  
Document Number 17, 70th Cong., 1st Sess.  
(Washington, 1928), pp. 1-15.

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\*Plans, surveys, and sketches accompanying this report not reprinted.

**TO THE HOUSE OF REPRESENTATIVES :**

To carry fully into effect the intentions of Congress, in making an appropriation of 5,000 dollars, by the act of the 14th of April, 1820, for the survey of the Ohio and the Mississippi Rivers, from the Rapids of the Ohio, at Louisville, to the Balize, for the purpose of facilitating and ascertaining the most practicable mode of improving the navigation of those rivers; orders were given, through the proper department, to the Board of Engineers, to examine and survey the said rivers, with reference to those objects, and to report their opinion thereon, which they have done; and which report I now communicate for the information of Congress.

**JAMES MONROE.**

**JANUARY 22, 1823.**



DEPARTMENT OF WAR,  
*January 22d, 1823.*

SIR: I have the honor to transmit, herewith, a report of the Board of Engineers, on the Ohio and Mississippi Rivers, made in obedience to your instructions.

I have the honor to be, your obedient servant,

J. C. CALHOUN.

The PRESIDENT OF THE UNITED STATES.

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ENGINEER DEPARTMENT,  
*January 16th, 1823.*

SIR: I have the honor to lay before you, duplicate copies of the Report of the Board of Engineers of a reconnoissance of the Ohio and Mississippi Rivers, made in the months of September, October, November, and December, 1821.

I am, Sir, very respectfully, your most obedient servant,

ALEX. MACOMB,  
*Mag. Gen., Chief Engineer.*

Hon. J. C. CALHOUN,  
*Secretary of War.*

## REPORT OF THE BOARD OF ENGINEERS ON THE OHIO AND MISSISSIPPI RIVERS

FROM AN EXAMINATION MADE IN THE MONTHS OF SEPTEMBER,  
OCTOBER, NOVEMBER, AND DECEMBER, 1821

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NEW YORK, *December 22, 1822.*

SIR: The following report of the Board of Engineers, on the Ohio and Mississippi Rivers, is respectfully submitted.

Your obedient servants,

S. BERNARD,  
*Brigadier General.*

JOS. G. TOTTEN,  
*Maj. Eng'rs. Brevet Lt. Col.*

To Brevet Maj. Gen. MACOMB,  
*Col. Com'd't of the U. S. Engineers.*

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In connection with this report, are the following plans:

1st, A plan of the Ohio, from Louisville to its mouth.

2d, A plan of the Mississippi, from St. Louis to New Orleans.

3d, A plan of the Falls of the Ohio.

4th, A survey of Bars No. 2, 3, 6, 7, 14, and 21.

5th, Sketches of Bars, No. 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, and 20.

6th, A sketch of the Canals, projected on the Kentucky shore, to avoid the Falls of the Ohio.

### REPORT ON THE OHIO AND MISSISSIPPI RIVERS

#### THE OHIO RIVER

The latter part of autumn and the spring, are the proper seasons for navigating the Ohio. It is not until December, that the rains, which fall in the extensive basin of this river, begin to swell its tributaries, and to render it passable below Louisville, with five or six feet draught. In January, the river is frozen; and, it is at the breaking up of the ice in February, and the melting of the snows at the same period, that the flood commences. These floods increase until May; then gradually diminish until July; after which, in July, August, and September, the river is very low everywhere, and can only be navigated below the falls by boats drawing two feet water. Rains of some continuance, however, occasion casual elevations of

water, even in these months. It is proper to remark here, that there is little precision in the periods just assigned to the different stages of the water; these periods vary with their causes, viz, rains, dry weather, frost, and thaws; they are sufficient, nevertheless, to show, that in general, the Ohio, below Louisville, is navigable, with five feet draught, only about six months in the year.

At the junction of the Alleghany and Monongahela (at Pittsburg), the Ohio begins; from this point to Louisville, by popular estimate, the distance is 700 miles; then, to the mouth, 400 miles, giving a total from Pittsburg, along the sinuosities of the channel, to the Mississippi, of 1,100 miles.

It is a peculiarity of all rivers, that, the nearer we approach the source, the greater we find the declivity of the bottom: During the season of floods, therefore, the velocity of the current should be greater in the Ohio above, than below the falls; and to this cause, without doubt, we may attribute the great difference which exists at those seasons, between the height of water above the summit of the falls, and at the foot of them; the water is, in fact, raised but about 35 feet on the summit, while it is at an elevation of from 57 to 60 feet immediately below. We may add, that the falls preventing all resistance to the upper current by the mass of waters below, the current must be more rapid, and its expense of water greater than the current below the falls; the water flows over these falls with an accelerated velocity, caused both by the declivity of the bottom, and the declivity of the surface.

The greater inclination of the bottom of the channel above Louisville, the falls accelerating the current at that point, and the less number of the tributaries, which the part receives; are so many reasons why, at the season of low water, the navigation is so much more obstructed by shoals above, than below that place. But, amongst the great number of obstacles which the Ohio River presents to navigation, the falls at Louisville are certainly the first in importance, for, if boats, coming from above and bound for the Mississippi, do not arrive at Louisville at the period when the superior and inferior waters are on a level, or nearly so, from floods, they are either obliged to pass the falls at great risk, or they are detained until the following year, or are compelled to discharge their cargo, and transport it in vessels constructed below the falls. All the country, therefore, connected with the Ohio, above Louisville, is deeply interested in opening a passage round the falls, which shall be practicable at all seasons when the river is so.

The falls commence about half a mile below the mouth of Bear Grass Creek, and flow over ledges of compact and hard calcareous rock. At low water these ledges are visible in many places; they then afford three passages.

1st. The northern, or right pass, between Goose Island and the right bank of the river. This is called the "Indian Shoot"; it is the principal channel, but can not be used at low water; at such times it is subdivided by the center rock into two, of which the right-hand pass (the best) is in one place sixteen feet wide, with sixteen inches draught at a mean of low water, and in extreme low water, only 13 inches. 2d. The pass between Goose Island and Rock Island, called the "Middle Shoot"; when the water is at a mean height, this is prac-



ticable. 3d. The pass between Rock Island and the Kentucky shore. This, called the "Kentucky Shoot," is only navigable at high water.

During low water the fall, from the mouth of Bear Grass Creek to the surface of the water at Clarkesville, is  $22\frac{1}{2}$  feet. We have observed before that, during a flood, the water rises more at the foot than at the summit of the fall; it would be satisfactory to have a table indicating the height of the water, both at the foot and summit, taken at corresponding times; but the construction of such a table would require a series of observations during the increase, continuance, and decline of the successive floods, and would require the actual presence of the observer for at least six months.

Bear Grass Creek affords, at its mouth, an excellent anchorage, well sheltered from winds and from ice. This anchorage extends down to Corn Island. We found there 12 feet depth at low water. Between Rock Island and the Kentucky shore is another anchorage (for boats) called Rock Harbor. There is also a third at Sandy Island, opposite Shipping-Port.

Several canals have been projected to get round these falls, and to connect the navigation of the river above with that below them. One proposition is to leave the river half a mile below Bear Grass Creek and rejoin it just below Shipping-Port; this is to have a single level, extending the whole distance, with four connected locks at the lower extremity; two traces have been suggested, of which one makes the distance 2,600 yards, the other 3,150 yards; the first would require a mean excavation of 24 feet; the second, a mean excavation of 30 feet. The bottom of the canal to be four feet below low water, above the falls; the earth to be removed appears to be, for the first fifteen feet, yellow clay; and then, a stratum of blue clay, mixed with sand, three feet thick; below this is a ledge of limestone, which, on a mean, must be excavated to the depth of six feet, for the bottom of the canal. It would be prudent to shut out the water of floods at the upper end, otherwise the banks of the canal would be much worn, and the locks endangered.

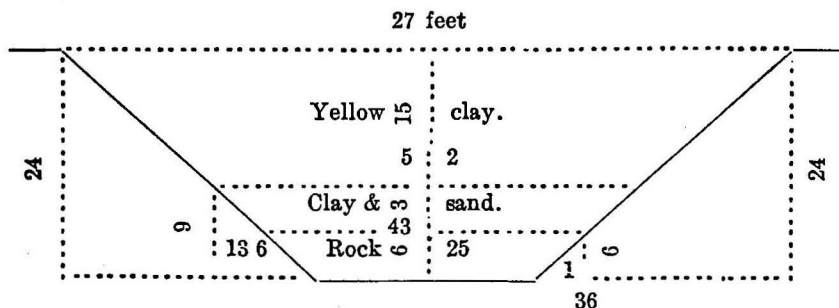
Another canal has been projected for the same side of the river; it is to leave the river between Corn Island and the Kentucky shore, and, following the windings of the shore, is to have its outlet between Shipping-Port and Rock Island. Its length will be about 2 miles, but it will require little excavation. As it will be entirely submerged by the floods, however, its four connected locks at the lower end, and its banks, will require a peculiar and very expensive construction to secure them from destruction.

A canal has also been proposed for the Indiana side; this is to follow the courses of two ravines, of which one enters at Jeffersonville, above, the other at Clarkesville, below the falls; it will be a little more than two miles in length. Having seen no details of this scheme, we can say nothing as to the nature and depth of the necessary excavations.

To judge of the comparative merits of these projects, it is indispensable to have well studied and minute plans and estimates. All that the board can say is that they are, all of them, practicable; and as to the expense, taking the first as an example, it can hardly be less than \$140,000.

# REPORTS ON OHIO AND MISSISSIPPI RIVERS

Adopting this as a mean profile of the first canal, with a length of 2,600 yards, the expense can not be estimated below \$131,464.76, to wit:



|  |               |
|--|---------------|
| 322,829 cubic yards of yellow clay, to be excavated and removed, at 20 cents per cubic yard  | \$64, 765. 80 |
| 41,165.8 cubic yards of sand and clay to be excavated and removed, at 20 cents per cubic yard  | 8, 233. 16    |
| 58,931.6 cubic yards of rock to be excavated and removed, at 50 cents per cubic yard   | 29, 465. 80   |
| Masonry, etc., of locks for, at most, 24 feet of elevation, to obtain a general level, supposing that the stones derived from the excavation may be used for the purpose, 24 feet, at \$800 per foot | 19, 200. 00   |
| Dam at the head of the canal, supposing that the stones excavated may be used in the masonry   | 10, 000. 00   |
| Total  | 131, 464. 76  |

Besides the great obstacle of which we have been speaking, there are many minor ones, which, however, completely intercept the navigation of the Ohio in its low stage, except to boats with very little draught. These are shoals of gravel or sand, extending quite across the river. The deepest water over these is confined to very narrow channels, generally; and great attention and experience, on the part of the pilots, are necessary to hit these channels and to avoid being drawn by the lateral currents upon the shoals. Though these bars have water enough for "keel and flat-bottom boats," which draw but about 18 inches, to descend the Ohio, from Shipping-Port to the mouth, at almost any season of low water; they have so little, as to prevent the navigation by steamboats (which draw from four to seven feet) for five or six months every year.

Between Shipping Port and the Mississippi, there are twenty-one of these bars, which we proceed to describe, successively, beginning at the Falls, premising, that the depths, as they are given, were actually ascertained by us in our examination (between the 16th of October and 3d of November, 1821); and that, according to information obtained by us, the minimum depth may be about 10 inches less.

The length of the bars are taken in the direction of the stream:

1st. Just below Shipping Port, between Sandy Island and the Kentucky shore, there is a chain of rocks running N. W. and S. E. across the river; on which, close to Sandy Island, there is six feet. Before arriving at the rocks, a sand bar is crossed, on which there is but four feet water.

2d. A little above the mouth of Salt River, the channel is obstructed by a sand bank, about 70 yards in length, which has but three feet water.

3d. About one mile above Big Blue River there is a bank of stones and coarse gravel; it is about 200 yards long, and has  $3\frac{1}{2}$  feet water.

4th. Below the same river there is a bar of stone and gravel, on which there is four feet; its length is about 80 yards; the current is very rapid.

5th. Five miles above Little Blue River there is a bank of quicksand, having three feet water, of 200 yards in length.

6th. Immediately below Flint Island there is a sand bank which narrows the channel between it and a similar bank, making from the opposite shore; the channel is 90 yards wide, with a depth of at least three feet, and a very rapid current.

7th. A mile and a quarter below the same island the river is obstructed by a sand bank of about 1,200 yards in length; for the distance of 360 yards there is three and a half feet water; for 240 yards, but two feet; and for the remaining distance of 600 yards, three and a half feet; the shoalest part is also the narrowest, the breadth being about 180 yards. This current is moderate. On the right shore, below Deer Creek, there is a rock, about 15 yards from the bank. At the surface of the water it is about 50 feet long (its length parallel with the shore) and 15 feet broad and rising 15 feet above the surface. In time of high water this rock, covered by a few feet of water, requires much attention on the part of the pilot.

8th. Two miles above French Island there is a sand bar of about 200 yards in length, and on which from 20 inches to two feet only are to be found. The channel is narrowed between the left bank and the upper shoal of French Island, being in the narrowest part but about 50 yards across. Between this island and the left bank there could be found but three or three and a half feet depth; here and upon the bar the stream is very rapid.

9. The bar above Henderson is about 150 yards long and has 3 feet water; the breadth of the channel is above 70 yards—the current very strong.

10. The bar below Henderson is 50 yards long—the channel 50 yards wide and the least depth  $2\frac{1}{2}$  feet.

11. Below Straight Island is a bar of two parts, one of compact and one of moving sand. The current is extremely rapid. The least depth is  $2\frac{1}{2}$  feet. The length of the bar is 150 yards and breadth of channel about 40 yards.

12. Between Willow Island and the right bank (in the Mississippi bend) the stream is very rapid. Below the island is a sand bank, on which the least depth is  $2\frac{1}{2}$  feet; its length is 100 yards; the breadth of the channel about 50 yards.

13. Three miles below Highland Creek, at the mouth of Lost Creek, a chain of rocks extends from the Kentucky shore, and narrows the channel upon the right bank to about 60 yards; at this place there is a bar of quicksand, on which is a depth of 3 feet—the length of the bar is about 100 yards.

14. Above Hurricane Island lies Walker's bar. Between this island and the Kentucky shore the channel is but about 60 yards wide, with a very rapid current. Walker's bar is of quicksand, its length about 100 yards; the least breadth of channel 160 yards, and



the depth of water 3 feet. The channel is very tortuous—the stream rapid, and the passage difficult.

15. Above the first Sister Island, at Buck and Deer Creek, there is a bar of quicksand 50 yards long, where the channel is about 40 yards broad, and 3 feet deep.

16. Below the third Sister Island, there is a bar of quicksand, on which there is  $3\frac{1}{2}$  feet water; its length is about 130 yards.

17. Below Stewart's Island there is a sand bank about 70 yards long, with 3 feet water.

18. There is a bar of moving sand opposite Lower Smithland, and below Cumberland Island; its length is 80 yards, and the depth over it 2 feet.

19. Two miles below the bar just mentioned, there is another, on which is a depth of 3 feet; its length is 60 yards.

20. The bar to the east of Tennessee Island is formed of moving sand: it is about 80 yards long, and has over it  $3\frac{1}{2}$  feet water.

21. The "Grand Chain" is a part of the river, where are many dispersed and detached rocks, resting on a bank or bed of rocks; the channel between these obstacles is very serpentine, its bed is of sand and gravel, its breadth is about 300 yards, and its depth is 3 feet. The stream is very rapid.

The bar at the confluence of the Ohio and Mississippi, having from 7 to  $7\frac{1}{2}$  feet water, is not an obstacle to the navigation, and is not, therefore, enumerated with the preceding.

From the details just given of the bars which obstruct the channel of the Ohio at low water, it will be seen, that, excepting those numbered 7, 8, 10, 11, 12, and 18, they have at least a depth of 3 feet; and that these six, having, respectively, 24, 20, 30, 30, 30, and 24 inches—only such boats as draw less than 20 inches can at low water navigate that river.

Before entering into an examination of the means which art and experience may present for removing these obstacles—a result greatly to be desired—it is proper to offer some general considerations in relation to the subject.

There are few rivers (except tide rivers) which are equally navigable during the whole year; for, as they are mainly supplied by rains and melting snows, their quantity of water must vary with the seasons. But the transition from high to low water is more or less sudden and depends upon the nature of the country which the river and its tributaries traverse; the higher and more sudden the floods, the shorter their duration and the sooner the river descends to, and the longer it remains at, its minimum. The floods of rivers are in fact not only in proportion to the surface of the basin which supplies it but also in proportion to the declivity of the sides of the basin; if the country be gently undulating and slightly inclined towards the river, the rains and melted snows arrive slowly at the river, and even a part is imbibed by the earth, to be added to the river only after the tedious process of filtration; in this case floods must be gradual in their increase, must fill the channel for a considerable time, and must be slow in their decline.

The height of floods, as well as their continuance, depends also on the duration of the season of rains and melting snows. The shorter this season, the greater, in proportion, the excess of water,

and the more brief its continuance; especially if these rains and snows are general, and arrive simultaneously by all the tributaries. In such cases, the floods are almost instantaneous—the expanse of water is very great, and the channel, widened by the flood, is too broad for seasons of low water; for the river, expanded over this greater surface, has given up in depth what it gained in surface.

A geographical circumstance, of great importance as regards the supply of rivers, is the situation of large lakes at or near their sources; these, by retaining the waters, are so many reservoirs, regulating the expanse of water in seasons of floods, and supplying an equivalent to this expanse long after the causes of floods have ceased.

Lastly, when a river takes its source among high mountains, where the melting of snows and ice is continued till midsummer, the supply must be much more gradual and continued than when the source lies in a secondary chain; for, in low mountains, the thaw begins everywhere at the same time and is soon over. Now, applying these principles to the Ohio, we shall see that this river is dependent on a country which is so situated as to favor a sudden elevation of its waters, while it is without those geographical circumstances which, by economizing the expanse of water, prolong the duration of the mean waters. 1st. Though the declivities of the basin are generally gentle, they are, on the Alleghany side, very rapid. 2d. The rains take place at the same time in every part of the basin, and affect, at the same time, all its tributaries; the case is the same with the melting snows, because the southwest wind, which prevails to the west of the Alleghanies, for nine or ten months of the year, blows exactly in the direction of the valley of the river, and acts in the same manner, at almost the same instant, on every part of the valley. It is only in January and February, that the N. W. and N. E. winds predominate; the latter takes the direction of the valley; the other affects the tributaries of the Ohio less equally. 3d. The Ohio has no large lakes at its source, nor has it auxiliaries. 4th. The chain of mountains to the east of the upper part of the river is not sufficiently elevated above the level of the sea to prevent the melting of the snows in the higher region from immediately following the thaws below; and the southwest wind will cause the thaw to take place sooner, and to occupy less time on the side of the chain tending toward the Ohio than on the other. 5th. Finally, the Ohio has its banks so high as to be seldom overflowed, which also contributes to the prompt discharge of its waters.

To be able to give an example of circumstances opposite to those of the Ohio we will cite the case of the Rhine. This river has its sources amongst the Alps, where the melting of the snows is successive, from points nearest the level of the sea, up to 8,300 feet of elevation; that is to say, up to the average height at which the eternal ice and snow of these mountains commence; this thaw is prolonged till June, and even till July. The Rhine, in its upper part, traverses lakes, which economise the expense of water, and serve as reservoirs for seasons of scarcity. Lastly, from the varied aspects of the numerous surfaces which form the basin of this river, and the different directions of winds, blowing at the same time in different parts of the general valley, the tributaries bring their contributions in succession. The floods of the Rhine are, therefore, not great; at

the bridge of Bale, the water scarcely rises 17 feet, and at Strasburg, but  $8\frac{1}{2}$  feet.

But, to return to our subject: The bed of the Ohio, enlarged to receive the mass of waters furnished by the floods, is, as we have said above, thereby too much expanded for the small quantity of water which passes at the low stage of the river; the water has gained surface and lost depth, and now becomes divided into small currents, which deepen their several channels a little, and leave the rest of the bed shoaler than before. The effect of these currents is modified by several causes, such as the nature of the bottom being less resisting in some places than in others; the direction and nature of the shores; the places, the form, the height, and the nature of the islands; and the result produced upon the bed, the shores, and the islands, by the mean and flood waters.

As to what concerns the effect of the waters upon the banks, at high and mean stages, it is evident that the parts the most friable and most opposed to the direction of the current will be most affected; salient and acute points in the river, offering less resistance, will be more perceptibly acted on than those which are obtuse. But the current, having worn off the parts most tender and most exposed to its action, may encounter veins of more consistence, or of less favorable position for its operation; it will then suddenly change its direction, and attempt upon the opposite shore the work of destruction, which was at last resisted by the shore it abandons. It happens also, that the current, having undermined a portion of the shore, will leave at the foot of the breach a portion of the ruins; these change, as they increase, the nature of the slope along which the river rushes against the bank, diminishing constantly the velocity of the current and the wear of the banks, until at last the waters are diverted from that course by the greater slope, which conducts them to an attack on the other side of the river. This continual wear of the current upon the banks, gives to rivers a course which is more or less serpentine, in proportion to the greater or less effect of this wear, and it is always observed that rivers passing through countries where they can produce such an effect as that above, are much more crooked than when they are found bounded by firm and durable banks, such as rocks; in this last case, the course of the river is generally a near approximation to a straight line. But, whatever may be the course of a river, whether more or less tortuous, if the depth and breadth of its channel be sufficient to confine the floods within its banks, or if a natural deficiency in this respect be remedied by dykes along the shores, there will be established, after a lapse of time, a sort of equilibrium between the shores, the bottom, and the velocity of current; after this period the changes will be of little consequence, except perhaps to the islands. The Ohio, perhaps, may be considered as having arrived at this state of equilibrium, and its limpidness shows, that its waters, and those of its tributaries, have but little effect upon their banks, for otherwise they would be turbid and charged with terreous particles.

Disregarding the banks, and the materials which compose them, entirely, in this view of the subject, if the bed of the river be homogeneous throughout, it will follow a uniformly inclined plane; for there will exist no reason why it should be scooped out in one place



rather than in another. But such is not the fact; in time of low water the stream winds along the bottom, and, during floods, the line of most rapid current passes through the points of greatest elevation, in the several transverse sections of the river. If the river, in its course, encounters shoals of materials somewhat firm, the result of deposition, or the ruins of breaches made by the mean waters or the floods, the waters accumulate as behind a dam, and, passing with great velocity over their tops, soon wear out a channel; the matter, thus displaced, is borne along by the stream until it loses its velocity, when it is deposited to form a new bar. In this respect it is with larger rivers, at low water, as with smaller ones in ordinary times; if the bottom is of materials which can be abraded, such as earth, sand, gravel, &c., the bed is deepened in the narrow parts, as far as to where the bed begins considerably to expand. This has been shown by profiles, taken lengthwise of rivers, with a view to modify their course, a sort of undulation in the bed being evident, giving the greatest depth to the narrowest, and the least, to the widest parts of the channel.

It follows from what has been said above, that if, to render a secondary river, or the channel of a principal river, more navigable at low water, a uniform slope be given to the bottom, not only will nature be continually acting counter to the expensive project, but, should it be continued, the water, by running down an inclined plane of great length, will acquire an acceleration of velocity, which will increase the expense of water to the prejudice of navigation. With respect to the expense of water it is proper to observe, that it will not do to judge of the quantity of water that passes, by the mean depth of the rivers; but by the mean height of water over the most elevated parts of its bed. In the Ohio, below Louisville, this mean height at low water, is about three feet; all projects which have for object to render this river navigable for boats drawing more than five feet, should be so contrived as to augment this mean height the least possible, for with it will increase the expense of water.

The only means which appear practicable to us is the construction of dykes, which, obliging the current to pass at a determinate point, will cause the deepening the channel at that point. These dykes are commonly elevated a little above low water; they operate by diminishing the velocity of the current above them, thereby economising the expense of water, at the same time constraining the current to rush with greater velocity through the narrow spaces to be deepened. These dykes across the river are ordinarily formed by rows of piles, driven with force into the bed, and strongly wattled together, the spaces between the rows being filled with such rough stones, or large paving stones, as the neighborhood can supply. This kind of dyke is the more stable, as, being only of the height of low water, floods, whether partial or general, pass over without injuring them. Such dykes may be constructed upon all the bars (of which there are 21) which obstruct the channel of the Ohio. But, as they must, with the exception of the sluice or passage way, extend quite across the river, the length of the whole can not be taken at less than 15 miles; the expense will, therefore, be considerable. The experiment might first be made upon those bars which have less than three feet water, which, succeeding, would open the navigation to

boats of two and a half feet draught, and would indicate, with much precision, how far the experiment would fulfil the object in view. Before engaging in so great a work, it is proper, at first, to be content with experiments; to study the habits of the river, at high, mean, and low water; to be certain as to the best direction to give the current which is to remove the bars; and, also, to ascertain the breadth which the sluices should have, so as neither to endanger the dykes by their narrowness, nor to fail of their object by their width.

As to the excavations which might be made across the bars, such a work would have a durable result only where shoals are composed of firm and compact materials; but, being of sand, not well compacted, or of moving sand, or even of quicksand (with one or two exceptions at most), the excavations would be filled nearly as soon as made.

The Loire opposes (at the season of low water) to navigation nearly the same kind of obstacles as the Ohio; there are only from 16 to 20 inches of water on the bars, and the boatmen are obliged to dig a channel of 17 or 18 feet wide, for the passage of their boats. To do this, the boatmen, to the number of 8 or 10, get into the water, and, while a part hold planks, with one end of each in the sand, guiding them with their hand, others draw along these planks by means of cords. These channels are made sometimes in less than six hours; at other times they require a day and a half; but they do not long remain after the passage of the boat, and are filled entirely in a day or two.

Amongst the first attempts for the improvement of the Ohio should be that at removing certain rocks (especially in the "Grand Chain"), which, besides rendering the navigation more difficult and dangerous in low water, are extremely dangerous when covered by a mean state of the river, or during the rise and decline of floods.

The expedient proposed above for obtaining a greater draught of water in the Ohio is the only one we can devise. The board, however, are not sanguine in their belief of its efficacy in all cases requiring remedy. It is certain that, by the dykes and narrow passages, the water may be deepened at any required point; but it is to be feared that in some places at least the localities may be such that the very materials thus carried off by the rapid waters may be deposited when they become comparatively quiescent in such a way as very soon to form a new bar below. The very great importance of the object in view and the want of any other resource will nevertheless justify an experiment.

Such are the remarks we have to offer as to the Ohio. We come now to the Mississippi.

#### MISSISSIPPI RIVER

This magnificent river, which unites in a manner the Gulf of Mexico with the Canadian lakes, is the great thoroughfare by which all waters from the Alleghenies to the Rocky Mountains pass to the ocean.

From the Gulf of Mexico to the mouth of the Ohio the distance along the channel is reckoned by the best-informed pilots at 1,100 miles; from the Ohio to the mouth of the Missouri, 220 miles; making

1,320 miles from the last river to the Gulf. The mouth of the Missouri may be considered as about halfway to the Falls of St. Anthony—reckoning this half also by the windings of the channel.

The Missouri contributes much more than the Mississippi proper to the mass of waters which flow down the lower river, and should therefore be considered the principal; it is singularly cold, muddy, and rapid. Its floods are annual, but do not arrive at any fixed period; they occur generally in June and subside in July, producing one in the lower Mississippi of 15 or 20 days' continuance. This flood is preceded by another which arrives in April or May, caused by the rains and melting snows of the upper Mississippi and its tributaries. This, preceding as it does by at least six weeks that of the Missouri, seems to indicate either that the sources of this last river are farthest north or more elevated above the level of the sea, or that their aspect retards the influence of the sun for a longer time than those of the Mississippi; or finally all these causes may conspire to delay the period of flood. Be that as it may, the numerous tributaries of the Mississippi, having their sources in succession from about the 34th to 47th degree of north latitude, throw their floods in succession into this common recipient, which is thereby gradually swollen and also thereby affected differently in different parts of its course. The floods in the lower part of the river commence sometimes in January, and decline in June; often, however, the autumnal rains of the southern region hasten their arrival, while long and rigorous winters in the north protract their duration.

In ordinary winters this river is closed at "Cap-Cinq-Hommes" (12 miles below Maddensville) by ice for five or six days in December or January, and in severe winters as long as 15 or 20 days. At such times only  $2\frac{1}{2}$  or 3 feet, it is said, can be carried from the Ohio to St. Louis. In common seasons, at low water, there are about 3 or  $3\frac{1}{2}$  feet—we found in November from 4 to 5 feet, and in a mean state of the water there is about 9 feet.

From St. Louis down to Cape Girardeau the Mississippi runs between banks generally of limestone, and, being thus confined by solid banks, its course is but slightly meandering, conforming pretty closely to a straight line. But below this cape the shores are low, alluvion, and easily abraded by the current, which becomes very crooked. This cape has been considered by geologists, it is believed, as a part of a broken barrier formerly retaining the upper waters, which were spread out into an immense lake.

Above the confluence of the Missouri, the Mississippi is as limpid as the Ohio; but below the waters are very turbid, with the great quantity of earthy matter which they hold in mixture; and this turbidness is always in proportion to the comparative quantity of water furnished by the Missouri. This, however, is not the sole supply to the turbidness of the Mississippi waters, because all its western tributaries, as well as the Missouri, are charged with terreous particles, and the Mississippi itself, constantly acting with great violence upon its alluvial banks, carries along its rapid current much of the finer particles which it displaces. Such being the causes, it is evident that the water must be most charged with foreign matter during floods.

When the floods of the Mississippi have attained their greatest elevation, the whole valley through which it runs is submerged and



presents a breadth of water in some places of 50 or 80 miles; but while the outspread waters of the last return, on the wane of the flood, again to the river, those to the west remain, forming lakes and swamps. It is necessary to observe here that the most elevated parts of this valley are directly upon the edges of the river, or are, more properly speaking, the banks of the river themselves, which may be accounted for in this way: That the waters, on leaving the channel, have a velocity so diminished that they can deposit a part of the matter they hold in mixture; the banks therefore not only receive the grosser particles, but the greater proportion; for as the water moves on it has continually less and less to deposit.

While the waters of this river are over its banks, the operation of the current being in proportion to its elevation and consequent increase of velocity, the changes which are produced in the bed of the river are great, sudden, and numerous; then are produced those multiplied turns and elbows which so strikingly characterize this great river and which increase its length to the double of what it would have been if its banks could have resisted its current. The corresponding concave parts of these turns are sometimes separated only by a very narrow neck, which, being cut through by the waters, which often happens, present a new and navigable channel of perhaps half a mile in length, in lieu of the old one of 15 or 20 miles. The abandoned channel is, in time, entirely divided from the river, except in floods, and on the west side, especially, becomes a lake.

Below "Baton Rouge," however, the Mississippi ceases to carry on its work of destruction and creation, and is, in a manner, mastered by the artificial embankments which confine it to its channel; here also its bed is deeper and its floods rise to a less height above its banks. In proportion as population increases these dikes will be extended up the river to arrest its ravages; time can alone people the extended margins of the river and from it alone can we expect the complete embankment of its shores. Like the Rhine, the Meuse, the Loire, the Po, etc., the Mississippi will one day be confined by stable limits to its bed, and have yielded to its ravages and the empire of its caprice only the islands which lie in the channel. Now, the hand of man, in that region, is too weak to contend with so mighty an adversary.

The Mississippi is more remarkable for its length and depth than for its breadth. The channel is rarely a mile wide below the mouth of the Ohio, and is often not more than half a mile. This breadth diminishes sensibly in the lower part of the river; below Natches, the river, becoming narrower and narrower, gains in depth what it loses in width, and the force of the stream being in the ratio of the height of the water, the islands are very powerfully attacked by it; for this reason they are much less numerous below than above Natches in the same distance; and below Baton Rouge there is scarcely one.

The Mississippi has never been regularly sounded in its whole length; it is considered, however, that the mean depth of low water between St. Louis and the Ohio is about 15 feet; this depth augments gradually on descending the river; at Natches, it is 72 feet; at La Foursche, 180 feet; at New Orleans and below, 240 feet. But at the junction of the river with the Gulf of Mexico, the current being re-

sisted by the quiescent waters of the sea, gradually loses its velocity, and deposits the earth with which it is charged; here is formed a bar, on which is a depth of only 14 or 15 feet; other deposits, besides this bar, composed of alluvion, and of trees brought along by the current, exist near the mouth; these deposits, at first unsteady, and even floating, became fixed in time, and presented so many islands, obstructing the confluence with the ocean; but the passages between these islands being protected from the waves and currents, by the islands themselves, were very favorable for deposition, so that, in course of time, they became one, and, joining the continent, projected it thus much into the sea. It is not, therefore, improbable that the mouth of the Mississippi was formerly just below Baton Rouge and that the delta of the present day is but the work of ages.

The bed of the Mississippi being thus elevated at its mouth the waters at the bottom can only escape by filtration; the great passage of water is, however, at and near the surface; and if we consider the great number of issues by which this passage takes place, and the great space over which the water is spread, we need not be astonished at not finding at the mouth a sensible difference between the surface at seasons of low water and floods. Besides the difference of level between the Gulf and the low water of the river at Baton Rouge is so inconsiderable that tides, when aided by winds, are frequently perceptible at that place.

As to the difference between high and low water, in the river, this varies in the several parts of its course. At St. Louis, it is from 12 to 15 feet; at the mouth of the Ohio, from 15 to 20 feet; at Natchez (380 miles from the Gulf), 50 feet; at Baton Rouge (200 miles from the sea), 30 feet; at New Orleans (80 miles from the Gulf), 12 feet; and at the Balize, upon the Gulf, it is nearly imperceptible. The difference, therefore, augments, in ascending the lower part of the river, and in descending the upper. This fact accords with the observation, that, in all rivers subject to inundation, the maximum elevation of waters is near the middle of their course—and it may be thus accounted for: The upper part is continually increased by the accession of its tributaries, while the lower has numerous issues, and a wider space through which to eject its waters.

We now pass to the difficulties which the Mississippi presents, in its actual state, to navigation. Those which result from the continual changes in the course of its channel, can, as we have said, only be remedied by time. Those which are wrought by the current acting upon the shores and islands, are accompanied by earthfalls of even acres of forests. Of the trees which are in this way precipitated into the river, some are borne off by the stream, some are lodged upon the shores, where they form "rafts," obstructing the navigation of certain "branches," and require to be avoided with great care; for, such boats as "flat boats" and keel boats, which are difficult to manage, being once within the draught of the current of these branches, can hardly hope to escape being wrecked upon these rafts. Others of these trees become fixed in the bed of the river. When so fixed as to preserve an immoveable position, they are called "planters"; but when, being inclined from the vertical, and pressed upon by the current, they move in regular or rather in uninterrupted

oscillations, they are called "sawyers"; "snag" is a term applied to either. When the whole river shall be dyked, or when the margin shall be deprived of its forests, then will these snags cease to accumulate, and be gradually removed; few now are to be seen below Natchez, and scarcely one below Baton Rouge. There are few islands below the former place to furnish them, and the descent of the heavy rafts of timber for the supply of New Orleans has almost cleared this part of the river of this obstacle to navigation. Nothing can prevent, in the present state of things, these snags from being annually fixed in the river; but they can be removed; machines can be contrived to raise them, or to break or saw them off at a proper depth. It is true that the labor will be continual; that the channel is constantly changing its course, and that some of this labor will be in vain; but it is also true, that the annual destruction of property, by these impediments to the navigation, is immense; and it is certain that the risk may be materially lessened. Many particular parts of the river, such as sudden bends, narrows, and shoals, which are extremely dangerous, have continued nearly in their present state for a great many years; even some particular and prominent snags are well known to have kept their stations for very many years; this indicates, pretty clearly, that the risk may be diminished. Besides, as regards the labor, this will be gradually diminished, it is presumed; because, if in the beginning, when it will have to encounter the ruins of ages, it can make a sensible impression, it can not be long before this labor can be compassed by moderate means.

The safety of navigation must depend mainly, however, upon the kind of boats employed, and upon the prudence and experience of the pilots. The boats in use are "flatboats" (or Kentucky boats), "keel boats," and "steamboats." The first can be managed only slowly and with difficulty, and are not, therefore, well adapted to avoid the obstacles which suddenly present themselves; they can not at all contend with the current. Their pilots are seldom well acquainted with the habits of the river. They make but one voyage a year, which is insufficient to inform them as to the changes which are constantly occurring in the channel. Keel boats are much more manageable, and are generally provided with good pilots. But steamboats, by the frequency of their passages, by the precision and certainty with which they may be steered, and by the experience of the pilots, of whom great pains are taken to secure the ablest, are the only boats adapted perfectly to the navigation. These have almost entirely superseded the use of barges, which were formerly the largest boats in use. Since the practice has obtained of separating the forward part of the hold in these vessels from the rest by a watertight bulkhead, which measurably secures them from serious accidents, even when they encounter snags, not much remains to be done for the security of navigation *as to these vessels*, whether as regards the upward or downward passage. Constant watchfulness on the part of the pilot and abstaining from running at night are still indispensable conditions of a voyage without accident.

We shall close this report by pointing out another species of hazard which such boats as are not easily and promptly managed must encounter.



At the time of high water currents of excessive velocity set directly from the river over the banks toward the interior; if a boat gets within the draught of one of these currents, it is only with great effort and labor that it can hope to regain the channel; they are often drawn in by them and dashed to pieces against the first obstacle. Dykeing the river along its banks can only prevent these lateral currents, and time alone can produce this result.

For the present, the security of navigation will depend, as has been said above, upon the kind of boats employed, upon the talents, the prudence, and the experience of the pilots, and upon the success of the attempts to diminish the number of snags.

All of which is most respectfully submitted.

BERNARD, *Brig. General.*

JOSEPH G. TOTTEN,

*Maj. Eng'rs Br. Lt. Col.*

## **Document 2**

# **REPORT OF THE SECRETARY OF WAR COMMUNICATING REPORT IN REFERENCE TO THE INUNDATIONS OF THE MISSISSIPPI RIVER\***

**Report of Lieutenant Colonel Stephen H. Long  
Corps of Topographical Engineers**

**19 January 1852**

**Senate Executive Document Number 49, 32d Congress, 1st Session  
Reprinted from House Flood Control Committee  
Document Number 17, 70th Cong., 1st Sess.  
(Washington, 1928), pp. 16-26.**

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**\*Report of Charles Ellet, Jr., not reprinted**

[Senate Ex. Doc. No. 49, 32d Cong., 1st sess.]

## REPORT OF THE SECRETARY OF WAR

### COMMUNICATING

#### REPORTS IN REFERENCE TO THE INUNDATIONS OF THE MISSISSIPPI RIVER

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JANUARY 21, 1852.—Read and ordered to be printed

JANUARY 22, 1852.—Ordered that three thousand additional copies be printed,  
three hundred of which are for the Topographical Bureau

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WAR DEPARTMENT,  
*Washington, January 20, 1852.*

SIR: In compliance with the resolution of the Senate dated December 9, 1851, "that the Secretary of the Department of War communicate to the Senate any reports which have been received in reference to the inundations of the Mississippi, and to state whether any further appropriation is required to complete the surveys and investigations heretofore directed," I have the honor to transmit herewith the report of the Chief Topographical Engineer, accompanied by the reports of Lieutenant Colonel Long, of the topographical engineers, and Mr. Charles Ellet, jr., civil engineer, and submitting an estimate of fifty thousand dollars for the ensuing fiscal year, for the further prosecution of investigations in reference to the inundations of the Mississippi.

I have the honor to be, very respectfully, your obedient servant,

C. M. CONRAD,  
*Secretary of War.*

Hon. W. R. KING,  
*President of the Senate.*

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BUREAU OF TOPOGRAPHICAL ENGINEERS,  
*Washington, January 19, 1852.*

SIR: I have the honor to acknowledge your direction to report upon a resolution of the Senate of the 9th ult., calling for such reports as have been received in reference to the inundations of the Mississippi; and to state whether any further appropriations are required, in order to complete investigations on that subject.

To execute the appropriation law of September 30, 1850, two parties were organized: One under Captain Humphreys, of the corps of

topographical engineers, the other under Mr. Charles Ellet, jr., civil engineer.

At the commencement, a board of engineers was organized, consisting of Lt. Col. Long and Captain Humphreys, with directions to report upon the required surveys and investigations. The report of the board will be found printed as Senate Ex. Doc. No. 13, 2d session, 31st Congress.

The duties of this board were, to "decide upon the extent and character of the surveys to be made"; after which Lt. Col. Long was to resume his former duties at Louisville, Ky., and Captain Humphreys was to "give his attention to the requisite surveys."

Afterwards, on the 18th November, 1850, a separate and additional party was organized under Mr. Ellet.

These parties went to work as soon as practicable, and pursued their investigations with great industry.

Unfortunately, the zeal of Captain Humphreys induced him to remain so long and so late in the field during last summer, on the lower parts of the river, as to produce the most alarming indisposition, and so protracted and painful a debility, that, under advice of his medical attendants, he was ordered to the north, and has been relieved from the necessity of making the required report.

On the 10th of October, 1851, Lt. Col. Long was directed to repair to Philadelphia, and from the notes of Captain Humphreys, and such information as he should receive from him, to make the report. This order, and another, placed Lt. Col. Long again at the head of the board to which he had been previously assigned.

The result of these arrangements has been to produce two reports:

One from Lt. Col. Long, dated 26th November, 1851.

One from Mr. Ellet, dated 31st October, 1851.

These two reports are now submitted, in compliance with the resolution of the Senate.

Lt. Col. Long, in his report, limits himself to an exposition of what has been done (by Captain Humphreys' command), and of what is yet required to be done. He also enters into the question of the funds wanted for future operations. From this last, an estimate is now submitted of 50,000 dollars, for the ensuing fiscal year, for the further prosecution of investigations in reference to the inundations of the Mississippi.

Mr. Ellet, in his report, goes into a statement of these inundations, and proposes remedies.

In the annual report from this office of 6th November, 1845, an effort is made to expose the pernicious consequences of what are called "cut-offs," as applied to the Mississippi and other similar rivers. This subject is treated more extensively in the report of Mr. Ellet, and the pernicious consequences of the practice more elaborately exposed. Mr. Ellet names several places on the Mississippi liable to these operations, and recommends measures to protect them against such efforts by man, or by the gradual action of the stream.

Also in the annual report from this office of November 14, 1850, it is stated, in reference to protection from inundation, "there have been suggested but two modes which offer any reasonable prospect of success: One to make additional outlets to the river during periods of high water, adapted to relieve the river when it should rise to a given



height, and so made as to avoid abrasion from the action of the discharging water; the other a system of judiciously arranged dikes or levees, or probably a judicious combination of both, according to facts and localities."

Mr. Ellet reasons with much ability upon these two ideas, pointing out favorable positions for the outlets and indicating the extent of the dikes and the dimensions which should be given to them. He considers the levees recommended, "averaging eight feet high and four hundred and fifty miles long, would involve an expenditure of probably not more than \$2,500,000. Such an expenditure would, in fact, be ample to protect the whole coast (river coast) below Red River, from the floods that are now felt. But such works would not protect the country above and would be incompatible with the drainage and reclamation of the delta."

He also calls to his aid a fourth accessory means of controlling these floods; that of reservoirs in the mountain gorges, near the heads of the principal streams. While I willingly admit that all the speculations of a man of intellect are full of interest and deserving of careful thought, yet I can not agree with him that these reservoirs would have any good or preventive effects upon the pernicious inundations of this river, and even doubt if the waters so proposed to be collected have any appreciable, and certainly not an injurious effect, upon the inundated region. These reservoirs can, of course, collect only the waters which shall drain into them and can have no possible influence upon other water below the reservoir draining space; or, in other words, from the immense plateau of country which lies between the headwaters of these rivers, or below points where gorges for reservoirs would probably be found.

My impressions are, that the pernicious inundations of these rivers are consequent only upon a general rain, or a general and rapid thaw of the snow, over this immense plateau. The calculation of downfall water has direct reference to this extensive plateau; and unless it can be shown that the vast supply of water from this plateau, or a large portion of it, would be collected and restrained by these reservoirs, I do not perceive their advantage to the system proposed to be adopted.

There is a reasoning of Mr. Ellet, referable to any system, which deserves much consideration. It can not be doubted by any one who has studied, that effectual remedies to the evil complained of force considerations of any system beyond the limits of any one of the affected States, and, in reference to unity of plan, the success of any plan, efficiency and economy, require the energetic action of some general supervising power. This idea involves considerations beyond my province to discuss. The result, however, to my judgment is very clear, either but little can be done, or the work must be done by the General Government.

Respectfully, sir, your obedient servant,

J. J. ABERT,  
*Colonel Corps Topographical Engineers.*

HON. C. M. CONRAD,  
*Secretary of War.*

REPORT ON THE NATURE AND PROGRESS OF THE DELTA SURVEYS  
OF THE LOWER MISSISSIPPI

By S. H. LONG, Lt. Col. T. E., Pres't. Topographical Board.

## OFFICE WESTERN RIVER IMPROVEMENTS.

*Louisville, November 26, 1851.*

SIR: In obedience to your instructions of the 10th ultimo, requiring a report on the nature, progress, and cost of the operations performed under the direction of Capt. A. A. Humphreys, of the corps of topographical engineers, for the purpose of ascertaining the most effectual method of protecting the alluvial grounds of the lower Mississippi against inundations; also, on the nature and probable cost of the operations remaining to be performed for the same purpose; I have the honor to submit the following, as the summary result of my inquiries and investigations in relation to these premises.

The impaired health of Captain Humphreys has been assigned as the occasion of my interference in this arduous and complicated duty, for which no other could be so well qualified as the officer under whose directions the operations were performed. But from recent personal interviews with Captain H., and from the representations of his physician, I am persuaded that the continual illness of that officer renders him unfit for the laborious task of collating and reporting on the proceedings had, under his direction, in relation to the required surveys of the Mississippi Delta, and I shall accordingly endeavor to perform the task, in a manner as brief as practicable, and in conformity to the best lights that can be obtained in relation to the same.

The system of surveys and investigations deemed most conducive to an adequate development of the facts and circumstances affecting the inundations of the lower Mississippi and the means of "protecting the adjacent country from their injurious effects," has been fully set forth and explained in the report of the board of topographical engineers, dated Napoleon, December 18, 1850, to which I beg leave to refer for any information that may be wanted in relation to the "required surveys." The surveys, &c., that have been made, and that are to be treated of in this report, are to be regarded as items embraced by that general system, and constituting merely a portion of the same. The items alluded to have been gleaned from the copious field-notes kept by sundry individuals employed on different departments of the field-work, and especially from the summary statements of Lt. Warren, G. C. Smith, J. K. Ford, J. Bennet, and others, serving in the several departments of the surveys. The surveys and observations at and near New Orleans, having for their objects the establishment of transverse sections of the river bed; the transit speed of the river currents across those sections, at different stages of the water; the proportional quantity of alluvial matter held in suspension by the river at each stage; the quantity of water and floating matter conveyed downward, in all stages, during a period of one year; the percentage to be deducted from this quantity on account of the floating sedimentary materials, or the sum total of sedimentary matter annually passing the sections; the maximum quantity of water, &c., that can flow between the river banks at New Orleans, without producing overflows, &c., &c.; were confided to the direction and supervi-

sion of Professor Forshey, who is still employed on this service, and is expected to persevere in it, during the lapse of one entire year, at least. Of the progress made in these operations, I have as yet failed to obtain any definite knowledge, except that the services of Professor F. have been performed with the most assiduous and careful attention on his part, and in a manner conformable to the instructions of Captain Humphreys, and satisfactory to that officer.

EPITOME FROM THE REPORT OF LIEUT. WARREN, OFFICIAL AND PERSONAL ASSISTANT OF CAPTAIN HUMPHREYS

The report of Lieut. Warren relates principally to operations under the personal direction and supervision of Captain Humphreys, and embraces the following items, unaccompanied by any specific results or statistics, except by reference to copious field notes not yet in my possession:

1. On the completion of the investigations and report of the board of topographical engineers, in the latter part of December, 1850, arrangements were made by Captain Humphreys for the commencement and prosecution of the surveys and other observations therein proposed.

2. The preliminary outfit for these purposes consisted of two quarterboats, three rowboats or yawls, together with the requisite cooking apparatus, provisions, and various implements necessary to the prosecution of geodetic and hydrographic surveys.

Surveying instruments, consisting of theodolites, compasses, chains, levels, &c., &c., were also procured and distributed among the surveying parties, in a manner adapted to the nature of the services required of each party.

3. Printed memoirs, books, maps, charts, and other public documents descriptive of the aspect, character, and changeable features of the vast alluvial district, constituting the spacious Delta of the lower Mississippi, were procured for the purpose of obtaining an adequate and authentic knowledge of the present and former condition of the great Delta district.

NOTE.—Inventories of the books, instruments, and other public property alluded to, have been prepared by Lieut. Warren and are herewith presented. (See Doc. A.)

ORGANIZATION OF FIELD PARTIES

4. The force deemed needful to the prosecution of the contemplated surveys was distributed into three distinct parties, in the following order, to wit:

A topographical party, consisting of two principal assistants, three subassistants, and twenty-nine laborers, including chainmen, axemen, boat keeper, steward, cook, &c., under the direction of J. K. Ford, Esq., assistant civil engineer.

A hydrographic party, consisting of one principal assistant, two subassistants, one pilot, seven boatmen, a steward, and cook, under the direction of G. C. Smith, Esq., assistant engineer.

And a hydrometric party, consisting of one principal assistant, two subassistants, two carpenters, two principal boatmen, one clerk, one

## REPORTS ON OHIO AND MISSISSIPPI RIVERS

messenger, and sixteen extra laborers and gauge observers, occasionally employed in making observations and performing sundry other services, under the direction of Prof. C. G. Forshey, assistant civil engineer.

NOTE.—A statement exhibiting the names, capacities, rates of pay, commencement and termination of service, &c., &c., has been prepared by Lieut. Warren, and is herewith presented. (See Doc. B.)

5. From a report of Lieut. Warren (See Doc. C) the following summary of expenditures incurred in the prosecution of surveys, &c., under the direction of Captain Humphreys, and within the period of his personal command, commencing on the 1st November, 1850, and ending on the 30th November, 1851, exhibits the proximate cost of the work and, of course, the amount drawn from the Treasury on account of the same. The summary is as follows:

### *Expenditures on account of Delta surveys in 1850 and 1851*

|   |              |
|---|--------------|
| Expenditures for the 4th quarter of 1850-----         | \$1, 662. 52 |
| Expenditures for the 1st quarter of 1851-----         | 10, 131. 16  |
| Expenditures for the 2d quarter of 1851-----          | 10, 487. 26  |
| Expenditures for the 3d quarter of 1851 (about)-----  | 9, 902. 47   |
| Expenditures for the 4th quarter of 1851 (about)----- | 4, 816. 59   |
| Amounting to-----                                     | 37, 000. 00  |

NOTE.—The last two items of the summary have been given as a near approximation of the amounts likely to be expended for the third and fourth quarters of the current year, the amounts remaining to be verified by sundry vouchers not yet received. The details of expenditures have been exhibited in a multiplicity of vouchers, accompanying the quarterly returns, already made to the Topographical Bureau, by direction of Captain Humphreys.

6. Agreeably to the document above cited (Doc. C), the expenditures on account of the hydrometric party, under the direction of Professor Forshey, are to be restricted to an amount not exceeding \$500 per month from and after the end of the current November. No returns or reports relating to the progress of the investigations committed to the charge of Professor Forshey have yet been received from that gentleman.

7. In addition to the assistance rendered Captain Humphreys by Lieut. Warren in the transaction of office business, Lieut. W. was employed from time to time in setting and adjusting river gauges at Donaldsonville, Baton Rouge, New Carthage, Natchez, Lake Providence, and various other points; and in directing topographical surveys in the vicinities of Bonnet Carré and Carrollton; also, in aiding the several parties above designated, in the performance of their appropriate duties. Early in June he ceased to participate in the field operations and resumed office duties in aid of Captain Humphreys, who, about this time, experienced a violent attack of a sort of cephalic neuralgia, which suddenly and effectually disqualified him for duty and still continues to frustrate all his efforts to transact the business of his station. In the meantime Lieut. W. has been employed in the settlement of accounts and the preparation of drawings and other papers relating to the Delta surveys. For an account of the services performed by him reference is had to his report, herewith presented, in the papers before cited. (See Doc. D.)



# REPORTS ON OHIO AND MISSISSIPPI RIVERS

## 8. EPITOME OF THE OPERATIONS OF THE TOPOGRAPHICAL PARTY, FROM THE REPORT OF J. K. FORD, ESQ., ASSISTANT CIVIL ENGINEER

The field or district comprising these operations is situated on the westerly side of the Mississippi River, commencing at a point above and in the vicinity of Routh's landing, near the upper mouth of Red River, and extending downward to Baton Rouge, and thence on both sides of the river and extending still farther to the city of New Orleans. The more considerable localities of the district are the following:

The Red River cut-off, mouths of Red River, head of Bayou Atchafalaya, Raccourci Island and cut-off, Tunica Bend, Point Coupée, Morganza, Bayou Sara, Port Hudson, Baton Rouge, Bayou Manchac, Plaquemine, Donaldsonville, Bonnet Carré, Red Church, Carrollton, and New Orleans. Surveys by compass and level were made on the right bank of the Mississippi, through the entire district, from a point five miles above Routh's landing to New Orleans; and on the left bank from the Red River cut-off to the Raccourci cut-off, and from Baton Rouge to Carrollton. Offsets on the right and left of the river, together with triangulations to determine the width of channels, bayous, &c., and numerous observations for determining the relations of surveyed lines to extreme high-water marks of the present and former years were made at most of the points above indicated and in various other localities. Agreeably to the report of Mr. Ford, herewith submitted (see doc. E), the lines surveyed in various subdivisions of the district embrace the localities, distances, &c., exhibited in the following table:

| Designation and definition of localities  | Nature of survey    | Length of surveyed lines | Total distances |
|---|---------------------|--------------------------|-----------------|
|   |                     | <i>Miles</i>             | <i>Miles</i>    |
| From Routh's landing to Raccourci cut-off, including Red River Island, Raccourci Island, &c., on both sides of the river. | Main lines.....     | 24.30                    |                 |
|   | Offset lines.....   | 8.48                     |                 |
|   | Triangulations..... | 6.70                     | 39.48           |
| From Raccourci cut-off to Baton Rouge, on right side of the river.  | Main lines.....     | 63.78                    |                 |
|   | Offset lines.....   | 8.47                     | 72.25           |
| From Baton Rouge to Bonnet Carre crevasse, on both sides of the Mississippi.  | Main lines.....     | 188.45                   |                 |
|   | Offset lines.....   | 64.99                    |                 |
|   | Triangulations..... | 52.47                    | 305.91          |
| From Bonnet Carre crevasse to Carrollton and the vicinity of New Orleans, on both sides of the river.                     | Main lines.....     | 57.50                    |                 |
|   | Offset lines.....   | 2.50                     |                 |
|   | Triangulations..... | 9.16                     | 69.16           |
| Aggregate length of lines surveyed on both sides of river.  | -----               | 486.80                   | 486.80          |

9. The drawings in plan, profile, and section, showing the extent and position of the lines surveyed, and the topography of the country traversed by them, are numbered in sheets from one to sixteen. They are still in an unfinished state, having been sketched merely in pencil delineations; but are of a character to illustrate, with great precision, the topography of country in the immediate vicinity of the lines surveyed.

NOTE.—The reports of J. K. Ford and Joseph Bennet, Esqs., herewith presented (see Docs. E and F) and the field notes therein referred to, explain in detail the developments brought to light by the surveys; although these developments are not yet sufficiently copious and extensive to reach the objects and answer the ends for which the

surveys were instituted. The field operations of the topographical party were terminated on or about the first of July; subsequently to which Messrs. Ford, Bennet, and Fuller have been employed in sketching the lines surveyed, and reporting the work done by the party.

10. EPITOME OF THE OPERATIONS OF THE HYDROGRAPHIC PARTY, FROM THE REPORT OF G. C. SMITH, ESQ., ASSISTANT CIVIL ENGINEER (SEE DOC. G)

The operations of this party were commenced at a point about ten miles below New Orleans, by running a compass and level line from the shore of the Mississippi, eastward to Lake Borgne, about six miles. By this survey it appears that extreme high water of the Mississippi at the point in question, in 1850, rose to an elevation of eleven and a half feet above the low-tide surface of the lake. This result having been determined, the hydrographic party proceeded to sundry points within the district traversed by the topographical party, as before designated; and established a multiplicity of sectional lines, stretching across the Mississippi, Red River, and numerous outlets and bayous of the former. The points at which they operated were as follows, viz. Carrolton, Rouths Landing, Red River Island and cut-off, mouth of Red River, head of Atchafalaya, old channel surrounding Red River Island, Raccourci cut-off and island, Towers Landing, Morganza, Bayou Sara, Faussi rivière, Wintersville, Baton Rouge, Bayou Manchac, Plaquemine, Bayou La Fourche, Bonnet Carré, &c. From the report of Mr. Smith, above cited, it appears that more than eighty sectional lines and soundings thereon have been established by the party, but the areas of the transverse sections, except in two or three instances, and the average velocities of the currents thereat, have not yet been computed or communicated, except merely by reference to copious field notes, not yet received.

11. In the prosecution of their work, the hydrographic party found it impracticable to take the transverse sectional soundings, with the requisite precision, by the use of rowboats; the current being too strong, and the maximum velocity too great, in very many instances, to admit of soundings across the river in right lines. For example, at Routh's landing, after a multiplicity of attempts, the party succeeded in ascertaining the proximate velocity of the river in the most rapid channel, and found it to be seven and one-fifth miles per hour; a current too rapid for rowboats to ascend, or even to traverse in a right line. The same was true, also, in relation to numerous other rapid passes in the river.

In order to obviate this inconvenience and difficulty, a small steamer, the *Byrona*, with one engineer and two firemen, was chartered for one month at six hundred dollars, by the use of which, the soundings could be effected with far greater accuracy than by the use of rowboats.

Thus equipped, the party were enabled to accomplish with the requisite precision a multiplicity of soundings on twenty sectional lines at and near Carrolton, and eight in the vicinity of Bonnet Carré; copies of the notes taken on the former were furnished to Professor Forshey, to enable him to make his observations at Car-

rolton with the certainty of obtaining reliable results. As yet, no communications covering the results obtained from these soundings, &c., have been received.

12. Since the close of the field operations of the party, Mr. Smith, assisted by Lieutenant Warren and O. Sackersdorf, Esq., has been employed in plotting the lines, &c., surveyed under his direction, and in preparing profiles or sections, together with the soundings, &c., showing the form and capacity of the river channels at those lines.

#### OPERATIONS OF THE HYDROMETRIC PARTY

13. The operations of this party have been carried on, for the most part, at Carrollton, a few miles above New Orleans, under the direction of Professor Forshey, the objects of which, as specified in the report of the topographical board, are: 1st, "The determination of a transverse section of the Mississippi near New Orleans, with the utmost care and precision; including all subordinate sections at the same point, from the lowest to the highest water surface of the river, not exceeding the height of the natural banks of the river, and in such a manner as to exhibit with accuracy all the subordinate sections corresponding to every rise of one foot, from the lowest to the highest stage contemplated, as above.

2d. "The average velocity of the river currents, corresponding to each of the different stages above designated, should be determined with the utmost precision; and the duration of each stage, for at least one entire year, should be carefully observed and noted in months, days, and hours, for the purpose of determining, as nearly as practicable, the aggregate annual duration of each stage, the amount of water conveyed annually through the river channel from New Orleans to the Gulf; and more especially the magnitude of the largest volume that can pass in the channel from New Orleans to the Gulf, without overflowing the banks of the river"; and, 3d. "a small quantity of water should be taken from the main channel of the river at each and every stage designated in the preceding item, for the purpose of having the water carefully analyzed, or of separating the earthy matter held in suspension by the water in each stage. The separation should be carefully and skillfully made, for the purpose of determining the quantity of sedimentary matter conveyed downward in each stage, and the annual amount conveyed by the river from New Orleans to the Gulf."

14. The known ability and fidelity of the gentleman to whom these delicate operations have been confided, give assurance that they will in due time be faithfully executed. The skill, care, patience, and perseverance of Professor Forshey, are sufficient guarantees for their effectual accomplishment. The progress made therein has not as yet been reported; nor can any final results be expected prior to the lapse of one entire year from the commencement of the observations.

15. Of the various operations contemplated in the report of the topographical board, and still remaining to be performed, the following constitute the principal items, to wit:

16. The completion of the observations, &c., intrusted to the direction of Professor Forshey.

17. The rectification of the level notes in a manner to show their relations to a plane of common reference, viz, to the level of low tide in the Gulf.

18. The completion of the drawings, in plan and section, explanatory of the surveys already made, and affording the requisite facilities for connecting them with delineations hereafter to be made.

19. The compass and level lines on one or both sides of the Mississippi should be extended downward from Carrollton to the Balize, with suitable offsets to the right and left, extending outward from the river shores to the level of tidewater, on both sides of the river.

20. The sectional surveys and observations proposed to be made across the Mississippi at some suitable point below the mouth of Red River (probably in the vicinity of Bayou Sara), for the purpose of ascertaining the entire quantity or volume of the river that must pass that point in extreme flood—with the view, also, of ascertaining the maximum volume that can flow past this point, compared with the maximum volume that can flow past the Carrollton section, without overflowing the natural banks of the river—remain to be made.

NOTE.—As stated in the report above cited, the difference in magnitudes of the two volumes in question is to be regarded as surplus water, which must be conveyed to the right and left from the Mississippi, through outlets or waste weirs at several points between the mouth of Red River and New Orleans in order to exempt that city and the country below it from overflow.

21. The individual capacities of the several outlets or waste weirs, Bayou Atchafalaya, &c., included, required to convey away the surplus water of the most excessive flood and prevent overflows at and below New Orleans remain to be determined.

22. The transverse compass and level line, or lines, extending eastward and westward entirely across the Delta region above and below the mouth of Red River, together with numerous offsets, extending from the same to the Gulf coast, &c., as contemplated in the report of the topographical board, was designed for the purpose of ascertaining the direction and positions of outlet channels proper for conveying the surplus water, &c., of the Mississippi, by the nearest and most favorable routes, into the open Gulf. These lines remain to be surveyed.

23. The number and positions of the outlets, and the directions and extent of the channels by which the surplus water should be conveyed to tidewater of the Gulf; also, the magnitudes of the channels through which the water is to be conveyed, with the least possible danger of producing inundations on the less elevated portions of the Delta region, remain also to be determined by the surveys mentioned in the preceding paragraph.

24. The surveys first considered have also for their object a development of the approximate capacity of all submarine cavities below the surface of the Gulf tides, with a view of ascertaining with some degree of precision the length of the period required to replenish those cavities with sedimentary matter deposited from the surplus water of the Mississippi and Red Rivers.

25. In the report of the topographical board the survey of sectional lines across Red River, at a point below the mouth of Black River, together with soundings and other observations, similar to those required at Carrollton, near New Orleans, was accidentally omitted. Surveys and observations for purposes similar to those



## REPORTS ON OHIO AND MISSISSIPPI RIVERS

required at Carrolton, viz, for ascertaining the quantities of water and silt actually conveyed downward through the channel of Red River and deposited within the Mississippi Delta, should be made.

26. The other surveys on the Mississippi, above the mouth of Red River, as contemplated in the report above cited, yet remain to be made.

### MEANS OF ACCOMPLISHING THE SURVEYS

27. I am creditably informed that the original estimate for this work was prepared agreeably to the direction of the Superintendent of the Coast Survey, and contemplated merely a hydrographical and topographical survey of the Delta region of the lower Mississippi, below the mouth of Red River. The survey of lines of level was not then regarded as an essential part of the work. The probable cost of the surveys, including soundings in all the water fields to be surveyed, but exclusive of the running of lines of level, was one hundred and twenty thousand dollars (\$120,000). To this should be added, on account of lines requiring the use of the leveling instrument, at least thirty thousand dollars (\$30,000) more, making the aggregate amount one hundred and fifty thousand dollars (\$150,000); which, in view of the unavoidable hardships, exposures, and dangers to be encountered, and the consequent limited portion of each year during which the surveys can be kept in progress, as also the high prices demanded for services under circumstances so unpropitious, may be regarded as a moderate estimate.

28. With respect to the probable cost of prosecuting the surveys during the ensuing year, it may be estimated as follows, viz:

|   |          |
|---|----------|
| Services and subsistence of assistant civil engineer in charge of hydro-metric surveys near New Orleans, at \$7 per day for one year, say---- | \$2, 500 |
| Services of three assistant engineers in charge of topographical and hydrographical parties, at \$6 per day each, for one year-----           | 6, 570   |
| Services of eight subassistants on various duties, at \$5 per day each, for one year, say-----  | 14, 000  |
| Services of one pilot and one steam engineer, at \$100 per month each, for eight months-----  | 1, 600   |
| Services of leadsman, steward, cook, and six boatmen, nine persons, at \$30 each per month, for eight months-----                             | 2, 160   |
| Services of axmen, chainmen, gauge tenders, etc., etc., thirty persons, for eight months of the year, at \$30 each-----                       | 7, 200   |
| Subsistence of field parties eight months, say fifty individuals, at thirty cents per day for each-----                                       | 3, 600   |
| One small steamer of light draught for soundings and hydrographic surveys, including outfit, say-----   | 10, 000  |
| Contingencies, including fuel, stationery, &c., say-----  | 2, 370   |
| Amounting to-----   | 50, 000  |

29. In the foregoing estimate I have included the probable cost of a light-draught steamer, the utility and necessity of which have been forcibly demonstrated during the progress of the surveys and other operations already performed.

I have the honor to be, sir, very respectfully, your obedient servant,

S. H. LONG, *Lieut. Col. T. E.,*  
*President Topographical Board.*

Col. J. J. ABERT,  
*Chief of Topographical Engineers, Washington, D. C.*

**Document 3**

**LETTER FROM  
LIEUTENANT COLONEL WILLIAM F. RAYNOLDS  
TO  
BRIGADIER GENERAL ANDREW A. HUMPHREYS,  
CHIEF OF ENGINEERS**

**(St. Francis River)  
December 6, 1870**

**Letter From the Secretary of War Transmitting Report of the Chief of  
Engineers upon the Improvement of Certain Rivers and Harbors  
House Executive Document No. 60, 41st Congress,  
2d Session, pp. 80-85**

No. 17.

OFFICE WESTERN RIVER IMPROVEMENTS,  
*St. Louis, Missouri, December 6, 1870.*

GENERAL: I have the honor to forward herewith the report of Mr. H. L. Koons upon the St. Francis River, with his estimates for the improvement of the same.

I cannot agree with Mr. Koons in recommending the construction of wing dams in a stream of little or no current. He estimates the entire fall from Wittsburg to the mouth, one hundred and thirty-five miles, at 17 feet, or only an average of 0.14 of a foot per mile, thus showing that this portion of the stream is little more than a bayou of the Mississippi, and the depth of water in it must be largely controlled by the water in that stream. If it should be thought desirable to attempt any improvement other than the removal of snags, it would, in my opinion, be best to do so by dredging, which would be less expensive and in all probabilities more effective.

I, however, agree with Mr. Koons that the present requirements of commerce would not justify an expenditure greater than would be necessary to remove the snags and fallen trees between the mouth of the river and Wittsburg. He reports that boats drawing three feet of water run to Wittsburg about eight months in the year, and that the removal of the snags would not only facilitate the navigation, but enable boats of sufficient draught to use the stream for ten months out of every twelve.

One light-draught snag-boat could navigate the stream at any time when it was one foot above extreme low water, and could probably remain in it long enough to remove all the snags, or about three months, which would require an expenditure of about \$15,000, and I would respectfully recommend that an appropriation of that amount should be made for the purpose.

I may add that this is another illustration of the great want of more light-draught snag-boats for the improvement of Western rivers, for the construction of which estimates have been submitted.

Very respectfully, your obedient servant,

W. F. RAYNOLDS,  
*Lieutenant Colonel Corps of Engineers.*  
Brigadier General A. A. HUMPHREYS,  
*Chief of Engineers United States Army, Washington, D. C.*

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## IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

OFFICE WESTERN RIVER IMPROVEMENTS,  
*St. Louis, Missouri, November 12, 1870.*

SIR: I have the honor to submit the following report, accompanied with a sketch of an examination of the St. Francis River, made in accordance with your order dated September 7, 1870.

It was found expedient to commence at Wittsburg. From this point the river was examined, a distance of 120 miles above, and 135 miles below—255 miles in all. For convenience, the description is begun at the mouth.

The examination was made between September 19 and October 25, 1870, at a very low stage of water. All heights and depths given in the report are from low-water mark.

From the mouth of the river to Ground Lump, twenty-three miles, there is not less than three feet of water; in most places there are nine feet. The river is six hundred to nine hundred feet wide, with channel from one-half to full width. The banks average thirty feet high, and are of sand; rough, abrupt, and in many places sliding. There are a few dangerous snags, the removal of which will somewhat deepen the shallow places.

On this portion of the river are two of the very few settlements on the St. Francis. Phillips's Bayou, on right bank, four miles from the mouth, contains some half dozen families. Jeffersonville, fifteen miles up on the same side, though a small hamlet, is a shipping point of some importance. It is at the mouth of the Anguille River, which steamers ascend twelve miles to Marianna, a town of one hundred and fifty inhabitants, and a regular point in the St. Francis trade.

Ground Lump is a mound of muscels and coarse gravel, with twelve inches water on top; it is so situated that boats are obliged to make a short turn and go between it and a shore bar, through a channel but sixty feet wide. It can readily be removed by dredging. It contains twelve hundred cubic yards. Near Campbell's Landing, one mile above, is a bar with two feet of water; the removal of four logs will deepen the channel about eight inches.

Ford's Bar, twenty-six miles above the mouth, is half a mile long; it has three feet of water, except at the foot, where there is but two feet for a short distance. It is greatly obstructed with logs and snags, the removal of which will make it a reasonably good piece of river. I consider this an important point with reference to improvement, as it is the principal impediment to low-bar navigation to the head of Black Fish cut-off. The fall on this bar is one and three-quarter inches.

South of this point the river has no fall, it being controlled by the Mississippi.

The river hence to the foot of Cow Bayou, eleven miles, has from six to eight feet water in the channel, and is five hundred to eight hundred feet wide. A fine piece of river.

Cow Bayou Bar has twenty inches of water for fifty yards, with a channel of one hundred and fifty feet wide. The fall is half an inch in four hundred feet. The removal of a few logs will increase the depth at least six inches.

From this point to the cut-off is a good piece of river; water from four to ten feet deep; wide channel; fall half an inch per mile.

Black Fish cut-off, fifty miles from the mouth, was washed out in the year 1857 by Black Fish Bayou, which enters it near its head. The cut-off is one and a half miles long; the old river fourteen miles around. The upper portion of the old river has filled up with sand and drift; the lower portion is navigable; boats ascending to Linden, a small village, six miles above foot of cut-off. The cut-off has from two and a half to six feet of water, is three hundred feet wide, with good channel, but very badly obstructed with logs, snags, and fallen trees, especially at its head.

The cut-off and Ford's Bar, cleared of snags, would open light-draught navigation to Burnt Cane, nineteen miles above, nearly or quite the entire year.

To Burnt Cane there is from six to nine feet of water; river from three hundred and fifty (350) to five hundred (500) feet wide; channel, one to two-thirds the width of the river, but somewhat obstructed with snags. The banks are from twenty-five to thirty-five feet high, and are of sand.

Burnt Cane Bar, sixty-nine miles from the mouth of St. Francis, at the head of Burnt Cane Bend, has sixteen inches of water for seventy yards, with a channel of one hundred and fifty (150) feet wide. The fall on this bar is at the rate of three inches per mile.

School House Bend, four miles above, has a crossing with two feet water.

Two miles above is the foot of Overcup Bend, which is four miles around, with a bar at either end, each with twenty inches of water, and about fifty yards in length. The bar at the foot of the bend has a fall of one inch; that at the head, a quarter of an inch.



## IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

North to the head of Pretty Tree Bend, two miles, there is from eight to twelve feet of water, with a channel much obstructed with snags, especially in Coon Island Bend, which intervenes. The fall around these bends is two and a half ( $2\frac{1}{2}$ ) inches per mile.

At the head of Pretty Tree is a gravel bar, with twenty inches of water, and a fall of four and a half ( $4\frac{1}{2}$ ) inches; channel wide but crooked.

For eight miles up there is not less than six feet water; channel wide; banks of sand, averaging thirty feet high. At this point is a crossing of twenty inches, readily improved by removing some logs. The river falls here at the rate of two and a half ( $2\frac{1}{2}$ ) inches per mile.

At Sandy Ground Bayou, three miles above, is a shoal seventy yards long, with twenty inches of water; fall, one and a half ( $1\frac{1}{2}$ ) inches per mile.

To Crow Creek Bend, one mile, is good water. Here is a short shoal, with twenty inches of water, and falling at the rate of three inches per mile.

To Madison, one mile, there is two to eight feet of water. Navigation of this part of the river is dangerous at any stage of water, on account of numerous snags and fallen trees.

Madison, one hundred (100) miles from the mouth of the river, by the cut-off, is the county-seat of St. Francis County; it contains two hundred inhabitants. The Memphis and Little Rock Railroad crosses the river at this point, on a bridge the span of the draw of which is said by the chief engineer to be eighty-four (84) feet. Madison is the mart of but a small territory, and, aside from a railroad-shipping point, is of little importance.

From Madison eight miles up, four feet is the minimum depth; but in places the channel is obstructed with snags, logs, and trees. At this point begins a straight piece of river, one mile long, containing several middle-bars, making a crooked channel. Between these middle-bars are two crossings of twenty inches water each.

To Big Eddy, five miles, there is eight feet of water; wide channel and unobstructed; a handsome piece of river.

At Big Eddy is a series of bars and shoals extending eight hundred (800) feet, and having but sixteen inches of water. The first bar has a fall of six and one-fourth ( $6\frac{1}{4}$ ) inches; the second, two hundred feet above, has a fall of one and one-half ( $1\frac{1}{2}$ ) inches. The material is coarse gravel and muscels. The river is five hundred (500) feet wide, with a channel narrow and crooked.

Eight hundred (800) feet above the river makes a turn of one hundred and forty (140) degrees; at the bend is a piece of deep water one thousand (1,000) feet wide, known as Big Eddy. Here Burnt Mill Bluff, a part of Crowley's Ridge, comes abruptly to the river.

The neck of land extending into the bend between the pieces of river does not exceed twenty feet in height for a distance of one and one-half mile from the eddy.

One-half mile above the eddy is a shoal three hundred (300) yards long, with sixteen inches of water. The fall is at the rate of two inches per mile.

To Anderson's Bar, four miles, two and one-half ( $2\frac{1}{2}$ ) feet is the minimum depth. The banks are twenty to thirty feet high; are of sand, with some loam.

Anderson's Bar has fourteen inches of water and a fall of one inch; channel thirty feet wide.

One and one-half mile above is Muscle Bar, with four feet of water and a fall of two inches.

To Allen's Bar, three and one-half ( $3\frac{1}{2}$ ) miles, there is five feet water; fall in the river of two (2) inches per mile. This bar has eighteen inches of water and a fall of two and one-half ( $2\frac{1}{2}$ ) inches. Just below is Allen's Ferry, one hundred and twenty-five (125) miles from the mouth of the river, at which point the military road crosses.

Hence to Wittsburg there is from four to ten feet of water; river from four hundred to six hundred feet wide; good channel; fall from one and one-half to two inches per mile; banks from twenty-five to thirty feet high.

Wittsburg, one hundred and thirty-five miles from the mouth of the St. Francis, by the Black Fish cut-off, is the county seat of Cross County.

The population is about one hundred and fifty. It is at the head of navigation, and is a town of considerable importance, controlling the trade of Cross, Crittenden, Poinsett, and Craighead Counties, with a portion of that of Mississippi and St. Francis Counties.

From the best data at hand, I estimate the fall of the river from Wittsburg to the mouth at seventeen feet.

Immediately above Wittsburg Landing is a bar, with four inches of water and a fall of one and a half inches. A half mile up is Goose Island, eight hundred feet long by one hundred and twenty feet wide, with an elevation of sixteen feet. At low stage all the water goes on the east side. There is a fall here of two inches. From the island to the east bank is two hundred feet.

## IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

The Bay Ferry Bar, three miles from Wittsburg, has twelve inches of water, and falls two and a half inches. The channel is very crooked. Between this and the preceding, the river falls three inches per mile.

Rock Island, twenty-six miles above Wittsburg, is five hundred feet long by seventy feet wide; the elevation is fourteen feet. The channel, which has six inches of water, is on the west side. There is a fall of twelve and a half inches in three hundred feet, or fourteen inches in all, this being the greatest fall in the St. Francis River.

The river banks are of sand, twenty-five feet in height.

The Tyrowza River enters the St. Francis three miles above; it is one hundred and fifty feet wide, with no running water at low stage.

Fortune Bar, 55 miles from Wittsburg; James, 65; Markham, 74; Sycamore Ford, 76; Broad Mouth, 79; and Mark Tree, 96 miles, are bars with from six to ten inches of water, and from one to three and a quarter inches fall. Between these is a succession of shoals, with from two to twelve inches of water. There are at intervals pieces of deep river, but all is badly obstructed with snags, timber, and fallen trees.

Little River enters the St. Francis by two mouths, three miles apart; the lower and principal one is 103 miles from Wittsburg. At low water it shows a dry bed over a large portion of its course.

The fall of the St. Francis, between ripples, from Little River to Wittsburg, will average  $2\frac{1}{2}$  inches per mile. The banks fall gradually from thirty feet at Wittsburg to fifteen feet at Little River; they are of sand, with a rich layer of loam on top, from three to eight feet in thickness.

Ten miles above Little River is the foot of what is known as the Lake and the Sunk Land. The New Madrid earthquake of 1811 caused a great area of this territory to sink from eight to fifteen feet, and turned the St. Francis into it. The country being originally heavily timbered the stumps remain, and the St. Francis here appears a stream one hundred and fifty feet wide, and from six to eighteen inches deep, without perceptible fall, and in a forest of stumps from six to forty feet high. The banks are from two and a half to three and a half feet high, and so flat is the country that a three-foot rise makes a lake from one to three miles wide.

The Lake is 70 miles in length. It is said there is a large raft thirty miles up, and also several places where the entire river is blocked with timber.

Maumel Prairie is a small settlement, twenty-five miles above the foot of the lake.

In times of a flood in the Mississippi, its waters cover the entire area between it and the St. Francis, and extend to Crowley's Bridge. A few levels taken will show the height of the overflow.

| Distance above the mouth.               | Ordinary over- | Greatest over- |
|---|----------------|----------------|
|   | flow.          | flow.          |
|   | <i>Feet.</i>   | <i>Feet.</i>   |
| Fifteen miles.....                      | 35.0           | 44.2           |
| Seventy miles.....                      | 36.8           | 48.0           |
| One hundred and thirty-five miles.....  | 36.5           | 46.3           |
| One hundred and seventy-five miles..... | 30.7           | 39.8           |

## IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

A rise in the St. Francis from its own resources has never exceeded eight feet at Wittsburg.

Crowley's Ridge runs north and south through this part of Arkansas, on the west side of the St. Francis. It rises one hundred feet above the bottom, and is from three to ten miles in width. Starting at Helena, it touches the river at Jeffersonville, near which it is pierced by the Anguille; it touches again at Madison, Double-Headed Bluff, five miles above, Big Eddy, and Wittsburg; between these points it is from one to ten miles distant. At Wittsburg it diverges, and is twelve miles distant at the lake. It extends to Chalk Bluff, a point on the river, near the Missouri State line. It divides the waters of the St. Francis and Anguille.

The St. Francis country is thinly settled, the slope of Crowley's Ridge and the highest points of the undulating bottom only being occupied. It is heavily timbered and has very rich soil.

The formation of the entire valley is sand; the bottoms, bed of river, and ridge are all of this material. The bottoms, however, have a thick stratum of loam overlaying the sand.

North of Wittsburg, the obstructions to navigation are so numerous and the trade of the country so small, that the expense of opening the river cannot be justified.

During the overflow, say forty-five days in the year, a few small flatboats bring down the entire shipments of the country.

There is trade enough between Wittsburg and the mouth of the river to support a moderate-sized, light-draught boat the whole year.

A four hundred and fifty ton steamer, drawing three feet, runs to Wittsburg, on an average of eight months in the year. The traffic, however, does not fill this boat to more than half its capacity, excepting during the cotton-shipping season.

Between Wittsburg and the mouth of the river there are 348 snags in or dangerously near the channel, and 92 fallen trees. Eighty per cent. of these are from eighteen to thirty inches in diameter, and very few exceed three feet. The timber is mostly sycamore, cottonwood, gum, and oaks.

To keep the river open to Madison at low water there will be required, in addition to the removal of the snags, six wing-dams, one at each of the following places:

1. Burnt Cane. 3. Foot of Overcup. 3. Head of Overcup. 4. Pretty Tree. 5. Sandy Ground. 6. Crow Creek.

To keep the river open to Wittsburg will require in addition five wing-dams, distributed as follows:

Middle Bars, two; Big Eddy; half mile above Big Eddy; Anderson's Bar.

Below is an estimate of the cost of these wing-dams. Owing to the absence of rock in the country, and the great distance it would have to be moved, if used, the estimate is made for dams of timber.

The current is very light at all of the points except Pretty Tree and Big Eddy, where the material is coarse gravel.

The estimate is made with a view of opening the river to steamers whose draught does not exceed two feet; such boats being large enough for the trade, at least during the low-water season.

The plan proposed is to drive two rows of piles, sixteen inches apart in the clear, cutting off the piles at the height of the dam. Between these two rows, place hewn timber, the top pieces at intervals, firmly bolted to the piles. This to form one side of the dam, eight feet from the center, to be the center of the other side of the dam, alike constructed. The ends to be similar to the sides, and iron clamps to connect the top pieces of timber at the corners. The inclosure to be filled with sand or gravel where it can be obtained.

# IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

## ESTIMATE OF THE COST OF WING-DAMS.

### *Mouth of river to Madison.*

|  |            |
|--|------------|
| Pile-driver, delivered.....  | \$2,500 00 |
| 2,928 piles, at \$1 75.....  | 5,124 00   |
| Driving 2,928 piles an average of 14 feet, at 15 cents per foot.....                         | 6,148 80   |
| 33,058 cubic feet hewn timber, delivered, at 18 cents per foot.....                          | 5,950 44   |
| 692 bolts, with nut and washer, 4 feet 6 inches by 1½ inches=31,140 pounds, at 6½ cents..... | 2,101 95   |
| 603 pounds wrought iron clamps, at 6½ cents.....   | 37 50      |
| 621 days' labor, at \$2 50.....  | 1,552 50   |
| 118 days' labor, at \$4 50.....  | 531 00     |
| 3,535 cubic yards filling, at 25 cents.....  | 883 50     |
|  | <hr/>      |
|  | 24,829 69  |
|  | <hr/>      |

### *Madison to Wittsburg.*

|  |           |
|--|-----------|
| 3,799 piles, delivered, at \$1 75.....   | 6,648 25  |
| Driving 3,799 piles an average of 14 feet, at 15 cents per foot.....                       | 7,977 90  |
| 41,444 cubic feet hewn timber, delivered, at 18 cents.....                                 | 7,459 92  |
| 900 bolts, with nut and washer, 4 feet 6 inches by 1½ feet=40,500 pounds, at 6½ cents..... | 2,733 75  |
| 500 pounds wrought-iron clamps, at 6½ cents.....   | 31 25     |
| 726 days' labor, at \$2 50.....  | 1,815 00  |
| 138 days' labor, at \$4 50.....  | 621 00    |
| 4,452 cubic yards filling, at 25 cents.....  | 1,113 00  |
|  | <hr/>     |
|  | 28,400 07 |
|  | <hr/>     |

Total—mouth of the river to Wittsburg..... 53,229 76

The removal of the snags between Wittsburg and the mouth of the river involves all the expenditure the traffic of the entire St. Francis County will justify at this time.

At present a steamer drawing three feet runs to Wittsburg eight months in the year. With the snags out, this time could be increased, and a boat of less draught, ample for the trade, could use the river at least six months in every year.

Very respectfully, your obedient servant,

H. L. KOONS,  
Assistant Civil Engineer.

Brevet Brigadier General W. F. RAYNOLDS,  
Lieutenant Colonel Corps of Engineers U. S. A.





## Document 4

AN ACT TO PROVIDE FOR THE APPOINTMENT OF A  
“MISSISSIPPI RIVER COMMISSION”  
FOR THE IMPROVEMENT OF SAID RIVER FROM THE  
HEAD OF THE PASSES  
NEAR ITS MOUTH TO ITS HEADWATERS

46th Congress, 1st Session  
33 U. S. C., sec. 641-647  
Approved June 28, 1879

*Laws of the United States*  
*Relating to the Improvement of Rivers and Harbors*  
*from August 11, 1790 to June 29, 1938*  
Volume 1, House Document No. 1491, 62d Cong., 3d Sess.  
(Washington, Government Printing Office, 1940), pp. 304-05.

LAWS OF UNITED STATES RELATING TO  
IMPROVEMENT OF RIVERS AND HARBORS.

June 28, 1879. **CHAP. 43.**—An Act To provide for the appointment of a "Mississippi River Commission" for the improvement of said river from the Head of the Passes near its mouth to its headwaters.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*  
That a commission is hereby created, to be called "The Mississippi River Commission," to consist of seven members <sup>[a]</sup>.

Mississippi River Commission.  
Vol. 31, p. 792.

Post, p. 938.

Number.

Selection.

Vacancies.

President.

Compensation.

Tenure of office.

Duties.

Detail of assistants, etc.

**SEC. 2.** The President of the United States shall, by and with the advice and consent of the Senate, appoint seven commissioners, three of whom shall be selected from the Engineer Corps of the Army, one from the Coast and Geodetic Survey, and three from civil life, two of whom shall be civil engineers. And any vacancy which may occur in the commission shall in like manner be filled by the President of the United States; and he shall designate one of the commissioners appointed from the Engineer Corps of the Army to be president of the commission. The commissioners appointed from the Engineer Corps of the Army and the Coast and Geodetic Survey shall receive no other pay or compensation than is now allowed them by law, and the other three commissioners shall receive as pay and compensation for their services each the sum of three thousand dollars per annum; and the commissioners appointed under this act shall remain in office subject to removal by the President of the United States.

**SEC. 3.** It shall be the duty of said commission to direct and complete such surveys of said river, between the Head of the Passes near its mouth to its headwaters as may now be in progress, and to make such additional surveys, examinations, and investigations, topographical, hydrographical, and hydrometrical, of said river and its tributaries, as may be deemed necessary by said commission to carry out the objects of this act. And to enable said commission to complete such surveys, examinations, and investigations, the Secretary of War shall, when requested by said commission, detail from the Engineer Corps of the Army such officers and men as may be necessary, and shall place in the charge and for the use of said commission such vessel or vessels and such machinery and instruments as may be under his control and may be deemed

<sup>a</sup> Act approved February 18, 1901, amends this act by adding thereto a section providing that the headquarters and general offices of the Commission shall be located at some town on the river, etc.

LAWS OF UNITED STATES RELATING TO  
IMPROVEMENT OF RIVERS AND HARBORS.

necessary. And the Secretary of the Treasury shall, when requested by said commission, in like manner detail from the Coast and Geodetic Survey such officers and men as may be necessary, and shall place in the charge and for the use of said commission such vessel or vessels and such machinery and instruments as may be under his control and may be deemed necessary. And the said commission may, with the approval of the Secretary of War, employ such additional force and assistants, and provide, by purchase or otherwise such vessels or boats and such instruments and means as may be deemed necessary.

Additional  
force.

SEC. 4. It shall be the duty of said commission to take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service; and when so prepared and matured, to submit to the Secretary of War a full and detailed report of their proceedings and actions, and of such plans, with estimates of the cost thereof, for the purposes aforesaid, to be by him transmitted to Congress: *Provided*, That the commission shall report in full upon the practicability, feasibility, and probable cost of the various plans known as the jetty system, the levee system, and the outlet system, as well as upon such others as they deem necessary.

Duties.

Report.

*Provided*.

SEC. 5. The said commission may, prior to the completion of all the surveys and examinations contemplated by this act, prepare and submit to the Secretary of War plans, specifications, and estimates of costs for such immediate works as, in the judgment of said commission, may constitute a part of the general system of works herein contemplated, to be by him transmitted to Congress.

Immediate  
works.

SEC. 6. The Secretary of War may detail from the Engineer Corps of the Army of the United States an officer to act as secretary of said commission.

Secretary.

SEC. 7. The Secretary of War is hereby authorized to expend the sum of one hundred and seventy-five thousand dollars, or so much thereof as may be necessary, for the payment of the salaries herein provided for, and of the necessary expenses incurred in the completion of such surveys as may now be in progress, and of such additional surveys, examinations, and investigations as may be deemed necessary, reporting the plans and estimates, and the plans, specifications, and estimates contemplated by this act, as herein provided for; and said sum is hereby appropriated for said purposes out of any money in the Treasury not otherwise appropriated.

Appropriation.

Approved, June 28, 1879.





**Document 5**

**A RESUMÉ OF THE OPERATIONS IN THE  
FIRST AND SECOND DISTRICTS  
MISSISSIPPI RIVER IMPROVEMENT  
1882-1901\***

by

**E. Eveleth Winslow  
Major, Corps of Engineers  
United States Army**

**Occasional Paper Number 41, Engineer School, United States Army  
(Washington Barracks, D. C., 1910), pp. 133-165.**

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**\*Plates not reproduced**

Memphis Harbor, as the term is here used, includes not only the wharf front of the city, but in addition to this the river for several miles up and down stream, and especially the right bank of the river from a point opposite Memphis upstream for about 4 miles. This part of the river is known as Hopefield Bend, and along it the bank has been revetted for a distance of over 3 miles for the purpose of preserving the wharf front at Memphis.

In 1877 the current flowed close to the right bank of the river from above Mound City Chute to above Hopefield Point. (Plate L.) Thence it crossed over to the left bank, which it followed from above the mouth of Wolf River to below the city. As this bank was caving rapidly, and was thereby endangering important interests, steps were taken to stop this caving, all of which have been fully described before.

In the meantime caving was steadily going on in Hopefield Bend, and this threatened Memphis with a new danger. It was feared that if the caving in Hopefield Bend continued, Hopefield Point would be entirely cut away and the current would cross to the left bank below the city. This would permit a sand bar to grow up along the city front, which would be, in this way, cut off from the river. This had happened at other places along the river, and that the fear for Memphis was not without foundation has been proved by subsequent events.

Consequently, the revetment works constructed in Memphis Harbor have been at two localities and have had two objects: First, the revetment of the city front to prevent the destruction of valuable buildings, etc.; and, second, the revetment of Hopefield Bend to prevent the recession of Hopefield Point, and the consequent destruction of the Memphis wharf front.

This work is located in the Second district, while Plum Point Reach is in the First, and as the districts were, at least for the first few years, separate, the development of the revetment work in these two localities went on independently.

Hopefield Bend began to cave rapidly in 1876. The cause of this increase in the rate of caving was probably the increased slope in this part of the river, due to Centennial Cut-off, which took place in that year at a point some 20 miles above. The records show that the bank at Mound City Landing, which was near the head of caving in 1882, had receded 1,100 feet between 1876 and 1882, while, below, near the middle of the bend, the recession had

been 1,800 feet during the same period, and this rate of caving at the latter place was increasing.

The plan adopted for protecting the bank was to clear it of all snags, stumps, or trees; then to cover the portion of the bank below low water with mattresses of brush work ballasted and sunk with stone, and to grade the upper bank above ordinary low water to a proper slope and to cover it with brush mat work, connecting with the subaqueous mat, and extending up the bank far enough to prevent scour. This bank work was to be well ballasted with stone.

Work at Hopefield Bend was begun near Mound City Landing in December, 1882.

The subaqueous mats employed were of the continuous woven type, built on a specially designed barge and in a manner similar to those first used at Plum Point Reach and already described, but with the addition of having poles attached to their top surface placed as follows: When a small portion of the mat had been launched on the river, the work of poling it was begun. This consisted in placing poles, called "binders," directly over all the poles used in the construction of the mats, which for distinction were known as "weavers." These were spliced together in the same manner as the weavers and were wired to them. These, with the weavers, supplied all the longitudinal strength the mat had. On the top of the binders other poles were placed transversely across the mat, usually about 8 feet apart, from the head to a short distance below, thence the interval was increased to 40 feet over the balance of the mat. They were spliced together as usual and wired to the mat where they intersected the other poles; when the mat was built to the required lengths, a strong pole selvage, similar in construction to the head, was placed at the lower end, and an additional line of poles was placed along the outer or river edge. The cross poles added strength to the mat in a transverse direction, and the entire pole system formed cribs, or pockets, on the surface and prevented to a considerable extent the shifting of the stone ballast when the mat was sunk.

The method of holding the mat in place during construction and sinking also differed from the practice at Plum Point Reach. Before the construction of the mat was begun, a barge of the same size as the mat barge, but without ways, was placed with its length perpendicular to the bank just above where the head of the mat was to be, and was held in place by lines to the shore above and by spars set against the bank. This barge, called the "mooring" barge,



held the head of the mat in place during construction, kept the drift off the mat to a great extent, and was of great assistance in sinking.

When the mooring barge had been securely fastened, the mat barge was brought up against it on the downstream side, and the mat construction was begun, the head of the mat being fastened to the mooring barge and also by cables passing under this barge to the shore above. This was done by securely tying to the mat-head short loops of 2-inch rope, called "strap" lines; the bights of these strap lines were connected with the head cables by iron shackles, the pins of which could be pulled after the mat was sunk, and thus all lines, except the straps, recovered.

To hold the mat to the mooring barge and to control it while being sunk, lines, with one end fastened to timber heads on the mooring barge, were passed around the poles of the mat-head, and thence back to the barge and around the same timber heads. These lines could be steadily payed out by the workmen while the mat was being lowered to the bottom of the river, care being taken to keep as far as possible uniform strains on them. They were called "slip" lines, were about 1-inch diameter rope, and were placed at intervals of about 16 feet along the mat-head.

When the mat had been constructed floating on the surface, the next step was to ballast it. A barge of stone was fastened along its outer edge, plank runways were placed from the barge to the mat and over the surface of the mat, and stone was carried to the mat by hand or in wheel-barrows, and was distributed on it evenly, so as to nearly overcome the buoyancy.

When ballasted, stone was next cast from the mooring barge on to the mat near its head, and this head was allowed to sink gradually, being lowered by the slip lines to a depth sufficient to allow a barge of stone to be floated in over it. This barge was pulled in parallel to the mooring barge, to which it was made fast by two lines, another line being run from the stone barge to the shore, where it was held by a gang of men. When all was in readiness, stone was cast overboard from all sides of the barge, and the slip lines were slacked out slowly and the head of the mat lowered to the bottom steadily and without surging. As the head of the mat sank, the stone barge was dropped downstream slowly over the mat, and the rest of the mat was sunk, the movements of the barge being controlled by the lines to the mooring barge and to the shore. At times a steamboat was used to assist in handling the stone barge.

After the mat was sunk, the stone barge was again dropped over it a second time and more stone cast on to weight it safely. As soon as the mat was found to be on the bottom at all places the mat lines were released, the shackle pins pulled out, all lines removed, and the mooring barge placed at the locality for building the next mat. This was usually placed so as to lap over the first mat by at least 25 feet.

The upper bank was graded by the hydraulic process to a slope of 1 vertical to 3 horizontal. Three streams were generally used, the two upper for cutting and the lower for washing down the material. The nozzles were  $1\frac{3}{4}$  and 2-inch diameter, mounted over a piece of gas pipe driven in the ground, where they had a universal joint permitting their control in almost any direction. In operating, the nozzles were held quite close to the bank to be graded and were moved through a range of from 45 degrees to 90 degrees with the face. The upper portion of the bank was cut slightly ahead so that the water could run down close to the face.

#### SEASON OF 1882

(Plate L.) During the season four mats were built and sunk, all 140 feet wide, extending from the mouth of Mound City Chute downstream 1,127 linear feet. The reason the mats were built in such short lengths was that the rising river and the drift which lodged against the mooring barges caused such heavy strains on the lines that it was not considered safe to build them longer. After the mats were sunk it was found that in two places, instead of the mats lapping, there were gaps of 15 feet between them. When it was time to sink the third mat, the stone supply was exhausted, and it was sunk with sacks filled with buckshot clay. In addition to the river mats, two narrow connecting mats were placed in an indentation of the bank to connect the river mats with the shore. The grader was worked one month, and about 1,900 linear feet of bank were graded, but no upper bank work was placed, as the river rose too soon.

#### SEASON OF 1883

Immediately after the subsidence of the high water of 1883 the work of the preceding year appeared to be in good condition and no caving had occurred, although the bank below had caved badly, but later in the season faults began to appear. On September 5, a cave occurred between mats Nos. 3 and 4, which had failed to lap





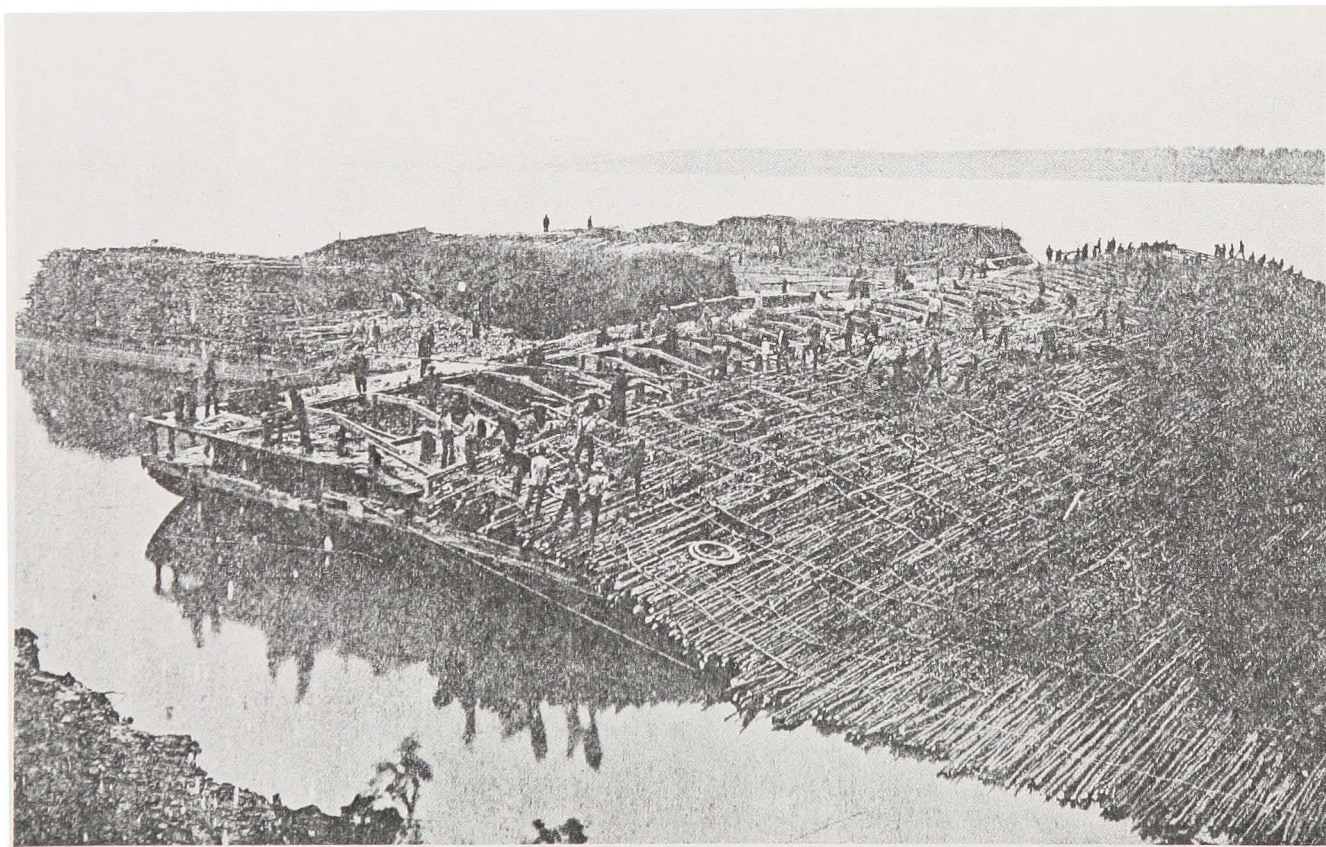
No. 8. Shows different stages of the upper bank revetment; part is complete and ready for ballasting. The brush here is placed at an angle of 45 degrees with the bank line.

by from 10 to 15 feet. This cave was of considerable size; it took in most of the graded bank, but from soundings made at the time did not extend far toward deep water. It was at once repaired with a river mat 300 by 100 feet and a revetment of the upper bank.

Operations were then begun on the continuation of the revetment downstream from the end of the work of the preceding season. The method of building and sinking the mats this season was the same as during the preceding season, except towards the latter part of the season, when wire strands were placed along alternate weaving poles to increase the longitudinal strength; these strands were made in short lengths and tied together. The same construction plant was used, and all river mats were made 145 feet wide. Their lengths, however, were materially increased, and after sinking five mats, varying in length from 493 feet to 1,032 feet, it was decided to build continuously, and the next mat was built to a length of 2,561 feet and sunk in two operations, when the mooring barge had to be removed to clear the drift. The next mat was 1,516 feet long and sunk November 20, after which a rising river and running drift prevented the building of very long mats. The first loss was sustained on November 30, in attempting to sink a mat 1,057 feet long. At this time a large amount of drift had accumulated above the mooring barge, and considerable had gotten under the head of the mat. The river at the time was rising and the current was strong. After ballasting the mat well and lowering the head some distance, much drift moved under the mooring barge and over the mat, tearing it away about 200 feet below its head. A few seconds later the mat lines broke, thus throwing all the strain on the slip lines, which transmitted it to the mooring barge lines, causing them also to break, and the mat and the mooring barge were thus torn adrift and started to float down the river. Extra lines were rapidly cast from the mooring barge to the bank and there made fast, the slip lines were thrown loose, and the mat moved away from the mooring barge, which swung around parallel with the bank. The mat, with stone barges attached to it, moved downstream, and the mat was abandoned as a total loss, the steamer towing the stone barges back to the work. In this accident all head lines parted, there being nine in all of from 1½ to 2-inch diameter, of which six were attached to the mooring barge and three to the head of the mat.

In the meanwhile another break had occurred in the 1882 work.





No. 9. Shows construction of fascine mattress at Ashport Bend in 1893; the mat was 300 feet wide,

This occurred on December 12 and was at the same locality as the one earlier in the season and completely destroyed the two lower river mats of 1882 and the repairs above mentioned. This cave was originally 440 feet long by 175 feet wide in the middle, but on December 17 the caving, owing to eddy action, extended until it reached a total length of nearly 700 feet. Soundings taken a few days after gave depths along the outer edge of the 1882 work of from 75 to 80 feet, where the original depths had been but 41 to 44 feet, showing that the cause of the failure was scouring under the outer edge of the mat. To repair this fault, two mats, aggregating 957 by 140 feet, were placed.

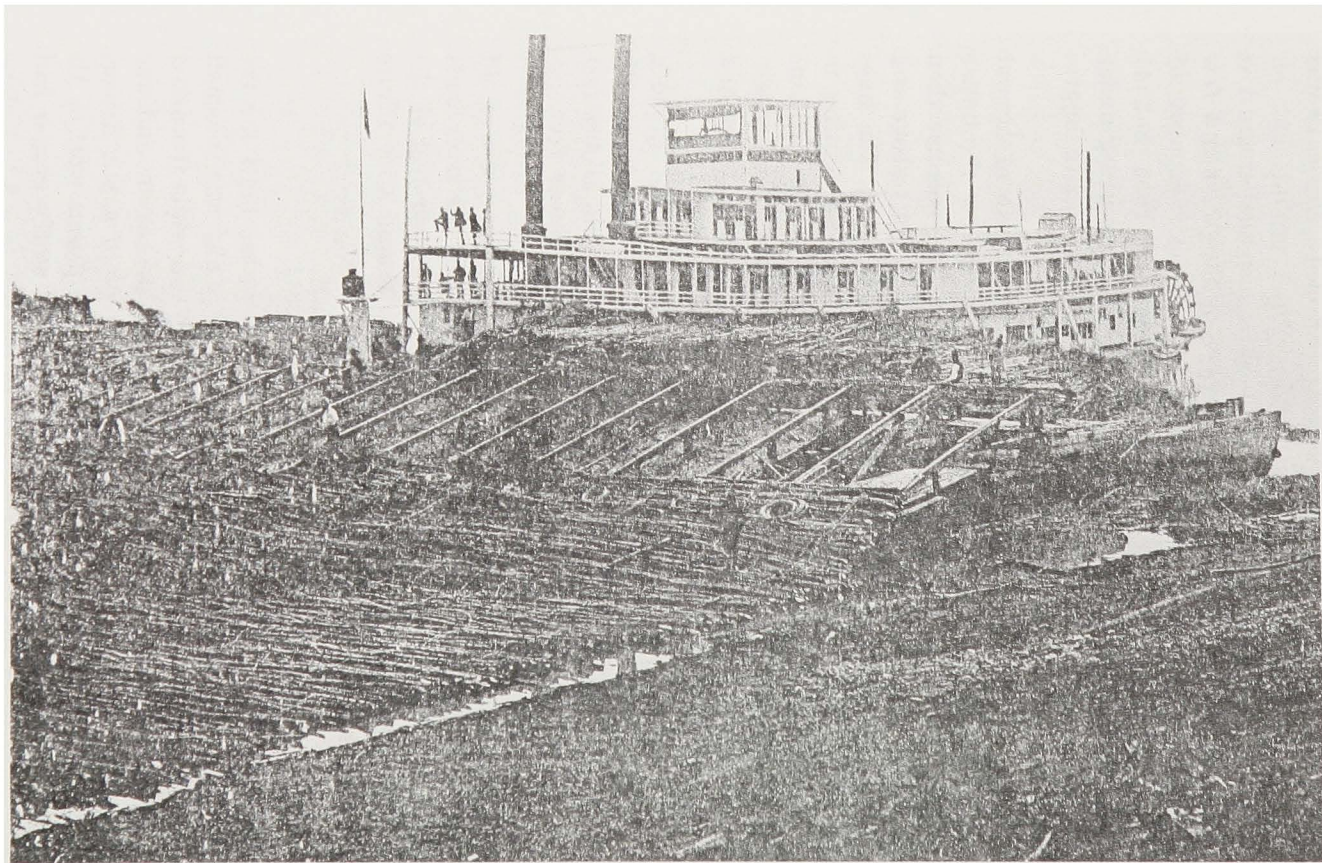
Work was then begun on revetting across the mouth of Mound City Chute; one mat, 210 by 140 feet, was sunk across the upper half of the chute, and in order not to interrupt the steamer then plying the chute another mat, 253 by 140 feet, was built above and dropped with lines across the lower half of the chute. The lines were then secured and the mat ballasted. But in attempting to sink it, the current was very strong, and the tug handling the stone barge fouled its wheel in the mat and in trying to get loose brought an additional pull on the already overstrained mooring lines and broke them, when the mat drifted away and was lost.

The work of this season comprised the construction of thirteen river mats, and of these two were lost in sinking. The total length built was 11,751 feet, of which 1,260 feet were lost and 10,491 feet sunk. Of the mats sunk, nine, aggregating 9,515 linear feet, extended the revetment downstream; one, 210 feet long, extended it upstream, and one, 766 feet long, was placed to make repairs of old work, and, including the work of the previous year, the river mats in place at the close of the season covered 10,450 linear feet of the bank; all continuous except a small gap in Mound City Chute near the head.

#### UPPER BANK REVETMENT

There being no large grader available, the grader built for the Delta Point (Vicksburg) work was obtained. This was a small machine and entirely inadequate for the work, and while it worked quite efficiently from September 1 to the end of the season, and was assisted for some time by the still smaller pumps of a pile driver, the grading could not be kept up with the subaqueous work. All grading was done after the mats were sunk, and as the grader had not the capacity to cut the entire bank to the top to a 3-to-1 slope





No. 10. An overhang is made on the mat-barge to lap the mat on the bank. The steamer shown is carrying the Mississippi River Commission on an inspection trip and has no connection with the work.

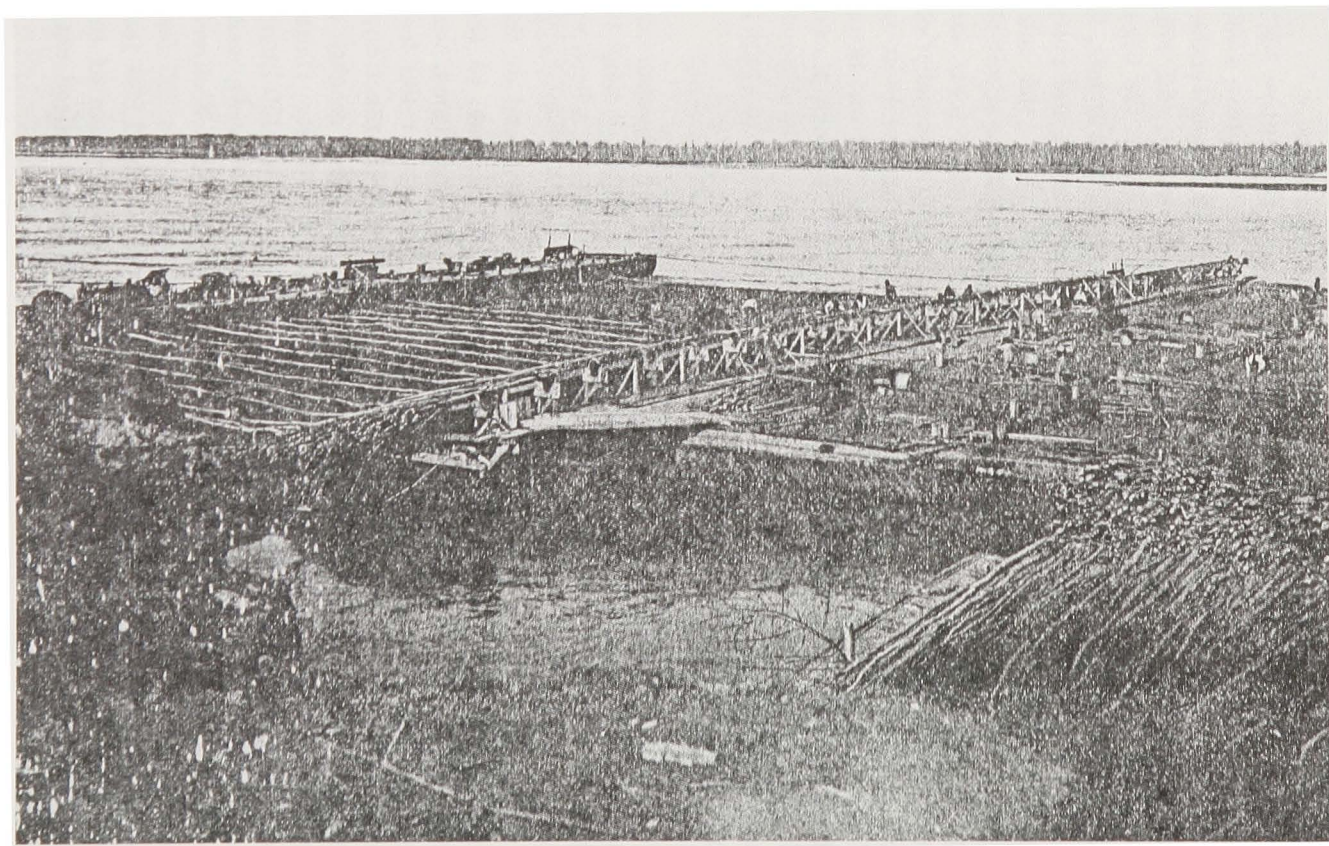
and keep up with the work, the slope was made steeper, or from 1 on 2 to 1 on  $2\frac{1}{2}$ , and a shoulder from 6 to 10 feet in vertical height was left at the top. In all, 9,290 linear feet of bank was graded, extending to within 1,000 feet of the end of the river mats.

The upper bank protection was placed along the entire 1882 work extended along the work of the present season to within 4,250 feet of the end, its total length being 5,700 feet. The construction was similar to the 1882 work along the Memphis front and consisted of two layers of brush and a wire grillage. When the work had to be extended over the water to properly lap the river mat, it was temporarily supported on stakes driven in the water, and poles were used in lieu of wires for the grillage, and where the subaqueous mats were too far from shore, as in a pocket, to admit of this construction a connecting mat, similar to the river mat, was used, and, owing to irregularity of the bank line, quite a number of these were required. Not all of the bank revetment was built as above, for the shortage of brush compelled the use of only one layer of brush over a considerable length. The width of the work placed wholly on the bank was from 40 to 45 feet, and the total bank work constructed, including connecting mats in the pockets, was 4,282 squares, placed along 5,760 linear feet of bank.

#### SEASON OF 1884

The high water of the spring of 1884 caused a slight damage to the revetment where completed, but farther downstream, where no upper bank work had been placed, the upper bank was cut away, thus completely flanking the river mats. At the lower end of the subaqueous mats the caving amounted to fully 500 feet; so the lower 4,250 feet, where no upper bank work had been placed, was entirely lost; the work remaining effective extended to 6,400 feet below the head. But even the revetment which had held intact during high water of this year began to fail when the river reached a low stage in the fall. One cave just below Mound City Chute destroyed all that remained of the 1882 work, and about 450 linear feet of complete revetment, with river mats 150 feet wide, were required for its renewal. Another cave at 4,600 feet below occurred in the shore work back of the river mats. This was at first 240 feet long, but afterwards increased until it required a mat 1,800 feet long and 100 feet wide to repair it; and still another cave of the same character, and a short distance below this, was repaired with





No. 11. Shows construction of fascine mattress at Caruthersville, 1898.

a mat 200 feet long by 75 feet wide, and along these caves upper bank revetment was placed.

The experience gained by previous work showed conclusively the necessity for carrying the revetment to or near the top of the bank, and of extending it under water practically to the foot of the slope to prevent caving by under-scour. Moreover, some caving appeared to have had its initial point at the junction of the river mats and the shore work on account of improper connection there, and this must be remedied by making a proper connection or a sufficient lap. The mats as previously constructed were quite open and should be made closer to avoid such large interstices and prevent scour through them, for even thus early it was thought that some settling of the work was due to the scour through the mats. In order to prevent the tearing of a mat in sinking, the strength of the longitudinal poles must be increased, and to prevent the loss of an entire mat in sinking, it must be anchored to the bank with more and stronger lines. These ideas were embodied in the following changes in the method of construction: The mats were made 150 feet wide, the shore edge being held against a line of piles driven at about the 5-foot contour line below low water, or an average of about 25 feet farther outstream than the mats of the previous year. This, with the 10 feet additional width, increased the total width of the subaqueous work about 35 feet. Instead of weaving one brush at a time over and under the poles for its entire length, a number of pieces were handled at once; these were spread out in a horizontal layer, with their butts over one pole, which they lapped about 2 feet. The brush was then passed under the next pole and over the second, and the tops were then thrown over on the mat already constructed. The tops of the brush thus woven were inclined upstream at a considerable angle. Other bunches of brush were placed in the same manner, with their butts shifted two poles apart, until a strip was woven entirely across the mat. Then the direction of the brush was reversed and another strip woven, the butts this time being placed over the poles intermediate to those on which the butts of the first strip were placed and the tops thrown over on the first weaving, which they crossed at an angle, thus making practically a double thickness of brush. This was called the diagonal method of weaving, and, while making a considerably thicker mat, it still contained many and fairly large holes. The top binding poles were then placed as heretofore and transverse poles wired on at 8-foot intervals. To increase the strength of the mat, five iron rods, one-

half inch in diameter, and two wire ropes of five-eighth-inch diameter were placed longitudinally along the binding poles, while other iron rods or wire strands were placed across the mat and along the transverse poles at intervals of about 40 feet, the ends of these wire strands being secured to fastenings on the shore or to the piling. All rods and wire strands were secured to the mat at intervals of about 16 feet with tie wires. The first iron rods used were 16 feet long with a welded eye in each end, and these were joined together with a malleable iron shackle and pin. Later, the eye was formed by turning the rod back and twisting it two or three times around itself. This was more expedient and insured more certainty in strength, as the welded eyes were often unreliable. The wire strands used were made on the bank by twisting from four to eight wires together, according to the strength required, and were made in lengths to suit their use. These were generally used for the transverse and shore anchor ties and were also placed along alternate weaving poles. The mooring and sinking of the mats was similar to the previous season. Four 2-inch ropes were attached to the mat-head, and from the point of attachment a wire rope or iron rod was run the entire length of the mat, and had there been stronger currents more mooring ropes would have been used.

Three mats, 150 feet wide and aggregating 3,407 linear feet, were placed, commencing at the then head of the caving, and as the mats were given long laps these protected only 3,300 linear feet of bank. Another mat, 686 feet long and 150 feet wide, was sunk across the gap at Mound City Chute, and over the first mat placed in 1882, which was in a shattered condition; 344 piles, of average length of 40 feet and average penetration of 15 feet, were driven along the shore to hold the edge of the mat.

Connecting mats were placed along nearly the entire bank and were made to lap the subaqueous mats about 24 feet outside of the piling. Their width varied from 75 to 150 feet.

In revetting the upper bank the work was extended to its top. Two layers of brush were placed, similar to last year, but poles were used for grillage instead of wire. The brush was well lapped over the connecting mats, and poles and wire strands were liberally used to make good connections with these. Wire strands of five-sixteenths and three-eighths inch diameter were run across the work transversely every 16 feet, from the river edge of the connecting mats to the top of the bank, and there fastened to trees, stumps,



or dead men. These were attached to the brush work at short intervals. Stone was used for ballasting, except toward the end of the season, when the exhaustion of the supply caused the use of gravel in sacks, of which 3,165 cubic yards were used. A total of 5,560 linear feet of bank was covered with upper bank work, of which 3,710 linear feet was along the river mats placed this season, and the balance was repairs to previous work.

This season's work, and including the work of previous years, completely revetted the bank for a length of 9,600 feet.

#### SEASON OF 1884

*Memphis.*—(Plate L.) While the work just described was in progress in Hopefield Bend, work of a similar character was being constructed in Memphis Harbor, to replace the early revetment destroyed by the spring flood of this year, and which has already been described. The exceeding deep water in this locality required much wider mats to reach the line of maximum depth. The greatest depth found was about 90 feet at a distance of about 300 feet from the shore. Therefore, the mats at some places were made from 250 to 300 feet wide. No guide piles were used, and the edges of the mats were encouraged to hug the shore as closely as possible. The first attempt at wide mat construction was made late in July, when the river was still high. Two mooring barges, built out of old coal barges, were placed end to end about 600 feet below Wolf River, and under these, two mattress barges, also end to end, were placed, and on each of these a mat 144 feet wide was constructed, with 12 feet of space between them, which it was intended to bridge over with brush and poles, making one mat; but after building 289 linear feet, the strong current and accumulated drift above the mooring barges brought such heavy strains on the lines that fears were entertained as to the ability to sink such a wide mat under the prevailing conditions. The outer mat was therefore cast off the ways and dropped with lines below the inner mat and pulled in to the bank and sunk, and afterwards the inner mat was extended to lap over it and then sunk.

A few days later the same mooring barges were swung out for the construction of a new mat 300 feet wide, the mat barges being so arranged as to weave this mat continuous in width. Owing to the strong currents, both the mat and anchorages were greatly strengthened. The mooring barges were held by nine ropes, one 2½ inches in diameter, six 2 inches, and two 1½ inches. Attached to the mat-



head were seven ropes, of which five were 2 inches and two were 1½ inches in diameter. Slip lines of 1 inch and 1¼ inch ropes, spaced 16 feet apart, were used to hold the head to the mooring barge for control in sinking. The mat was constructed by weaving the brush in the diagonal manner, as already described. Running along the top binder pole their entire length, and secured to the mat with wire ties at numerous points, were fifteen iron rods and wire-rope cables, and transversely across the mat at intervals of from 24 to 40 feet wire strands were run to the bank and there fastened. As an additional security in sinking, 1½ and 2 inch ropes were attached to the inner portion of the mat at every 100 feet of its length and run diagonally to upstream fastenings on the bank.

After building 690 linear feet, the mat was well ballasted, and on August 26 the operation of sinking began; at this time the current was strong and a large quantity of drift had accumulated above the mooring barge, and considerable had passed under the mat and lodged there. The head of the mat had been sunk in the usual manner, and the sinking of the rest of the mat was progressing when the drift rolled downstream under the mat and caught about its middle, where some of it pushed up through the brush work; this concentration of the drift, together with the strong current, produced strains greater than the mat could resist and it tore in two, somewhat like a piece of cloth, breaking the poles short off on the line of rupture, parting most of the iron rods at their nearest eye, while two of the wire ropes held, and the mat below stripped from them. The portion above the break, 365 feet long, was sunk to the bottom in good shape, not one of the mooring lines attached to the barges and mat having broken. The lower portion, 325 feet long, swung around 90 degrees, or until the lower end was parallel to the bank, and a part of it rolled up into a mass of shattered brush and poles, all tied together by the iron and wire ties. Some of the diagonal shore lines still held the broken part, and additional ropes were hurriedly run to it from shore. After examining the wreckage, it was found that 100 linear feet of the original lower end of mat was in good shape and this was cut loose and sunk. The balance, 225 by 300 feet, was pulled out in the river by the steamboats and cast adrift. After this accident, preparations were at once begun to build another wide mat, the width of which was reduced to 250 feet. More and stronger iron rods and wire strands were used, and in addition to these a rope was run along its outer edge,

and two others parallel to this at 16 and 32 feet, respectively, from the outer edge. This mat was built to a length of 479 feet and was well secured to the bank with numerous heads and side diagonal ropes. The river was still at a good stage, with strong current, and much drift running, considerable of which got under the mat, and in attempting to sink it on September 6 the mat tore apart about 10 feet from its head, the rupture not occurring until the mat-head was apparently on the bottom and fully half of the mat submerged. The break was precisely similar to the first one, all the head lines holding, but the strain was so great that many of the timber heads on the mooring barges were nearly pulled out and the barges badly strained, and if the mat had not broken it is doubtful if the barges would have held together. After the mat broke it swung in to the shore, as some of the shore lines still held it, and was there secured. The upper portion, a rolled up, broken mass, was cut away and pulled out in the river, and the balance, 239 by 250 feet, being in good condition, was secured and sunk without difficulty, there being no drift to contend with, as this was turned loose with the wreckage. The two accidents above described proved conclusively that it was unwise to attempt to sink wide mats at this locality in such strong currents and with drift running.

It was therefore decided to postpone work on the wide mats until more favorable river conditions, and in the meantime to collect material for making the mats still stronger. This was done by using more and larger iron rods and wire strand and by joining the former together in a more efficient manner. Thus, instead of using single rods with welded eyes, and uniting them with malleable iron shackles, the rods were made with twisted eyes, as already described. The size of the rods was also increased to three-fourth inch in diameter. These were placed along alternate poles or 16 feet apart, and along the weaving poles under these rods were placed hand-made wire strands. These changes in construction added greatly to the tensile strength of the mats.

As the mooring barges previously used were of too light construction, stronger ones were substituted, with more and larger timber heads for holding the lines. Preparations having been completed and the river having reached a favorable stage, work was resumed on November 6, and a mat, 610 feet long by 250 feet wide, was sunk on November 20, extending from about 400 feet below Wolf River to below the foot of Winchester street. Two more mats of the same width were then built, extending the wide mattresses below the foot of Poplar street.

In the construction of the first 610 by 250-foot mat four manila ropes and seventeen chains of iron rods were run through its entire length; the mooring barge was anchored by nine cables, and seven ropes were attached to the head of the mat, the two outer being 2½-inch diameter and the others 2-inch diameter, and in addition three 2-inch ropes were fastened to the mat near its middle and led to bank fastenings above. In the construction of the other wide mats the ropes from the middle of the mat to the shore were omitted, as they interfered with the proper handling of the stone barges in sinking, and were of doubtful utility. Prior to building the three wide mats above described, subaqueous mats 150 feet wide were sunk along the entire length of the bank. These mats extended from 1,230 feet above Wolf River to below the head of the paved levee at Jefferson street, a total length of 4,680 feet; and in addition to these a mattress sill composed of two mats, each 150 feet wide, was extended some distance up Wolf River, covering its bed from bank to bank and lapping the mats in the Mississippi.

There was sunk during the season 8,162 linear feet of mats, of widths from 144 to 300 feet, and having an area of 14,852 squares. Of the 4,680 feet of bank revetted this season, 365 feet were 300 feet wide; 1,566 feet were 250 feet wide, and the balance was 150 feet wide. As the 144 and 150-foot mats were covered by the wide mats, along 960 feet of the bank there were three thicknesses of mattress, and along 971 feet two thicknesses.

#### UPPER BANK WORK

The bank was graded to a slope of 1 on 3, part by the hydraulic process and part by hand, there being a number of places where the hydraulic graders could not be worked to advantage. The upper bank work was then laid and was of the same character as that constructed this season at Hopefield Bend. It was carried to the top of the bank, and was also well joined to the river mats, and wherever connecting mats were required these were built to lap the river mats from 25 to 30 feet. The total amount of upper bank work constructed was 5,711 squares, and including the 10,134 squares covered by the river mats the total area of bank revetted was 15,845 squares.

#### SEASON OF 1885

*Hopefield* —Although the previous season's work at this locality was of an improved type, and had been increased considerably in

width, and carried to the top of the bank, and was of strong construction, still, after a short period of high water, it showed very material signs of weakness, and early in March five places were observed where the work near the top had settled. These failures or faults increased in number until, at an examination made in September, when the river was down to the zero stage, nine breaks were found. The most extensive of these nine breaks was in the 1,000 feet next above the head of the 1884 work, in which length only about 60 feet of the shore revetment was unbroken. An examination showed that the bank had caved back a considerable distance, especially along the upper portion of the break, with deep water along the original location of the inshore edge of the subaqueous mat, and as soundings with rods failed to disclose the existence of this mat, and as the depths had increased, it was probable that the mat had been broken up and had drifted away.

Three of these breaks, aggregating 1,200 feet in length, were shallow caves above the top of the bank at the 1883 work. At these places the original shore work was quite inferior and was only carried up to the middle or two-thirds stage. The examination showed that the subaqueous mats were in place, with the shore edges but a few feet below the zero stage.

The five remaining breaks were all along the new and completed revetment of last season; in three of these the brush work of the upper bank revetment had settled, sliding down the bank in such a way as to be buckled or folded into longitudinal ridges extending across each break just above the low-water line. In another of the breaks, 270 feet long, the sliding of the upper bank work was so great that for about half its length in the middle all the work was below low water. There was no evidence of buckling here, as the whole work had apparently slipped bodily out toward deep water. Soundings along these last faults showed that the river mats had settled considerably, and when the water fell low enough to expose the guide piles it was found that those in front of the faults had settled bodily; that is, that they had moved riverward for a short distance, still retaining a nearly vertical position. It was at first thought that the breaks were caused by scour through the interstices of the mats, but this would have left the top of the piles at their original levels, and the fact that the piles had settled showed almost conclusively that the cause of the trouble was the scour under the outer edge of the mat, undermining the bank and allowing it and the revetment on it to slide down the steepened slope. The



mats placed had been too narrow by from 50 to 100 feet to reach to the line of maximum depth, and it is probable that there would have been no failures had their widths been sufficient.

*Memphis.*—No damage was done by the high water of this season to the revetment here, although the current had been very strong.

#### WORK OF THE SEASON

The work in this vicinity this season was confronted with a scarcity of funds, due to the failure of an appropriation bill. No money at all was available for the Memphis work, but a small fund was obtained for the most urgent repairs to the Hopefield revetment. This consisted principally in repairing the largest and first mentioned break. This was located on a salient in the bank where the width of the river was small and the current strong, and it was considered important that it be repaired before another high water, as otherwise the entire work below it, 3,300 feet long, might be lost. This was done by building a subaqueous mat 150 feet wide by 1,085 feet long, and as the water line was quite serrated, a number of connecting mats were required to connect with the upper bank work. This latter was carried to the top of the bank. The other repairs made consisted in placing additional cables to the old work and tying them to trees on the bank and in distributing 974 cubic yards of stone over the portion where sacked gravel had been used. The sacks had decayed, and the gravel having been scattered was no longer of use as ballast.

#### SEASON OF 1886

No material damage was done this season to the Hopefield work, but below the end of this revetment the unprotected bank caved rapidly. By March 1 the point at the lower end of the bend had receded about 300 feet. This allowed the current to strike the Memphis front much farther downstream, or at about the foot of Beal street, and produced comparatively slack water along the revetment above Jefferson street. No damage was done to this.

Along the paved landing from Jefferson street to Beal street the current was strong and threatened the destruction of the whole of this landing place. The increase in the current along the high bluff below Beal street was quite marked, resulting in rapid caving, threatening the destruction of the railroad tracks and a number of valuable manufacturing plants. The caving carried away part of a grain elevator and some inclines to the ice company's storehouse,

caused the removal of some oil storage sheds, and approached to within a few feet of Tennessee street, on which the tracks of four railroads were located.

#### WORK OF THE SEASON

It was this year that there was passed the appropriation bill that contained the clause prohibiting bank revetment, and this prevented any extension to the Hopefield work. But in the bill Memphis had been specially excepted from the provisions of this clause, and a small, special allotment had been made for extending the revetment along the city front. As stated above, the steamboat landing was threatened with destruction, and it was deemed important to protect it against any possible loss. Work was begun on the subaqueous mat only, no upper bank work being required, as the landing was well paved. Only the lower 2,300 linear feet of the subaqueous mattress work could be constructed during this season, and the remaining 700 feet at the upper end were left to be finished during the next season. At the time this latter was placed the conditions had changed so much that the current was quite slack along its site, and there appeared to be little necessity for it. The lower mat, 675 feet long from Beal street up, had a width of 285 feet; the next above, 567 feet long, was 265 feet wide, and the 1,772 feet extending to Jefferson street was 250 feet wide. Below Beal street, as was stated, much damage had been done by caving and more was threatened, and as the Government had no funds to protect this bank the railroad companies and property owners organized and raised funds to the amount of \$55,000, and with this sum and certain materials which the Government had on hand, and with the use of Government plant, the work of protecting this bank was executed under the direction of the engineer officer in charge by the construction of a series of brush and poles crib spur dikes to break up the dangerous current. This work will be described later under the head of Revetment by Spur Dikes.

#### SEASON OF 1887

*Hopefield.*—The high water of this year continued the caving below the end of the revetment, and this caving, of course, extended upstream behind the revetment and involved some loss to it. In fact, before work could begin, this end of the revetment had been so damaged by eddy action that 1,500 feet of the lower end had to be abandoned, and new work was begun that distance above

the original end of the 1884 work. There was also a small break in the 1884 work about 100 feet long; otherwise the old revetment was in fair condition, except that the exposed brush was showing marked signs of decaying.

#### WORK OF THE SEASON

From the appropriation of 1886 an allotment of \$60,000 had been made for revetment work in this bend, but the trouble over the clause in the bill prohibiting bank protection prevented this allotment from being available in 1886. Finally, however, in 1887 the special exceptions in this clause were interpreted to cover this locality and the allotment become available.

The method of construction of the subaqueous work was practically the same as heretofore, but the mats were made 196 feet wide to more fully cover the slope. Some changes were made in cabling the mats, the use of iron rods being discontinued, and wire strands in continuous length were used instead. Short wire strands were run along alternate weaving poles as heretofore, and from all the strap lines continuous-length wire strands were run over the entire length of the mat and tied to it every 16 feet. The transverse cables were placed every 32 feet and made continuous from the outer edge of the mat up the bank work to fastenings on top.

A slight modification was made in the construction of the upper bank work by placing the brush layers at an angle of 45 degrees with the bank, the usual pole grillages being used. No particular benefit was derived from this method, and the labor cost of placing the brush was slightly increased.

The result of the season's work was the construction of 4,000 feet of revetment work at the lower end and the repair of a small break in the 1884 work.

The 1887 work was placed along a portion of the bank which had been rapidly caving for a number of years, and at the head of this work the recession of the bank had been about 900 feet since the commencement of the work in 1882, while at the foot the recession had reached 2,400 feet and the caving had increased still more rapidly below, so that at Hopefield Point the river bank was 2,800 feet back of the 1882 line. The effect of this had not only been to relieve the strain against the Memphis front, which was desired, but the caving had been so great as to allow the formation of a large eddy, extending to below Jefferson street, and threatening to quickly ruin the upper portion of the harbor by the building up of

a sand bar along it. It was thus evident that to prevent the absolute destruction of the Memphis wharf front this caving at Hopefield Point must not be allowed.

#### SEASON OF 1888

*Hopefield.*—No breaks occurred along the revetment during the high water of this spring, but the bank caved below it, reaching a maximum of 200 feet at the Point.

Work was begun late in the season, about October 15, and a considerable rise in the river in November caused a delay, the result being that, in order to complete the revetment to the Point before high water, some of the mats were sunk at too high a stage, and, consequently, did not extend to the foot of the slope, and this permitted a more rapid failure of the work later on. The method of construction was exactly the same as that of the previous season, the subaqueous mats were of the same width, and the revetment was extended to Hopefield Point, a distance of 4,650 feet. In addition to the above, the 1887 revetment was reinforced at places with additional stone ballast.

#### SEASON OF 1889

*Hopefield.*—No damage was done this season to the existing work, and no work was done either in repairs or extension to the old work.

#### SEASON OF 1890

*Hopefield.*—The flood of 1890 destroyed a portion of the work of 1887 at its extreme lower end, making a break 762 feet long; this was repaired in the fall of that year by constructing 900 linear feet of revetment. The only change made in the method of construction was to make the upper bank work continuous with the subaqueous mattress. This was done by extending the mattress over an overhanging structure, built on one end of the mat barge, to lap well up on the dry bank. By this means a better connection could be made with the upper bank work and fewer connecting mats were required. The river mat was made 200 feet wide, but as the water was moderately high the inshore edge was placed about 25 feet up the bank, leaving only 175 feet of width beyond low water. The width of the entire revetment, including upper bank work, varied



from 290 to 360 feet, averaging 325 feet. The work done was a complete revetment 900 by 325 feet.

#### SEASON OF 1891

*Hopefield.*—During the high water in the spring of this year the current along the 1884 work, and for some distance along the 1887 work, was exceedingly rapid. This effected the destruction of all the remaining revetment of 1884, 1,800 feet long, and involved the upper 950 feet of the 1887 revetment. Another break just above the repair work of 1890 and in the revetment of 1887 destroyed 600 linear feet of this work. In some places the caving extended beyond the top of the upper bank revetment, while in other places portions of this were left, with large and deep holes cut out between it and the subaqueous mats. An examination made by a diver, and by probing with a long wooden rod shod with a steel point, proved that the river mats were still in place, but their inner edges at some places had settled to 20 or more feet below low water and were from 50 to 140 feet out from the new low-water shore line, but the condition of the mats could not be determined. Another break occurred near the close of the low-water season just at the head of the 1885 work, destroying about 400 feet of the revetment. Then there were also four small ruptures along the 1888 work, all of which were situated near the low-water line. From the appearance of the breaks it was evident that the initial point of rupture was along the lower portion of the shore work, the brush of which was badly decayed from the result of three or four seasons' exposure to the atmosphere. It was therefore decided to abandon the use of brush above low water and substitute for it an all-stone revetment laid directly on the earth, the stones to be of such sizes that when closely laid they would make a pavement of about 10 inches in thickness, and in order to preserve the brush shore mats still in place, it was decided to cover them entirely with stone. The substitution of an all-stone for the ballasted-brush upper bank work had been first tried experimentally at Plum Point Reach in 1888. The experiment was successful, and this type has been adopted as the standard for that class of work.

In the construction of this season the subaqueous and connecting mats were built the same as heretofore and were placed along all the breaks, and they were made of sufficient widths to extend to deep water or to connect with the former mattress work, where it was reasonable to suppose, from the examination made, that this was

in place and in good condition. Thus along all of the 1884 work, where the caving had been great, a length of 1,965 feet, the mats were made from 200 to 220 feet wide. Along the break near the lower end a mat 120 feet wide was found to be sufficient. This latter mat was 613 feet long. The total length of river mats placed was 2,578 feet, covering 4,764 squares.

Connecting mats from 30 to 30 feet wide were placed where necessary to make a safe connection with the paving above, and those portions of the connecting mats above extreme low water were closely paved; 5,725 linear feet of bank were covered. The upper bank was graded along 3,475 linear feet of the work, and 55,649 square yards were paved. Over half of the paving was on earth where it was made 10 inches thick, while the balance was on old brush work and averaged about 6 inches in thickness. The paving along the old 1884 and 1887 work, where all the upper bank work had been destroyed, was carried to the 22-foot stage, while over the existing old bank work it was carried to about the 17½-foot stage only.

#### SEASON OF 1892

*Hopefield.*—During the 1892 flood the current along the entire revetment was exceedingly strong and breaks occurred, aggregating 4,200 feet in length, and in most places these were of sufficient width to destroy the entire shore work along them. Careful examinations failed to disclose the presence of the river mats along three of the breaks, while along the others the mats were in place, but the inshore edges had settled considerably. Three of the breaks, aggregating 2,200 feet in length, were along the work of 1887, and this practically destroyed all that remained of the original work of that season. The other two breaks, aggregating 2,000 feet, were along the 1888 work.

In addition to the breaks, the revetment had settled at a number of places along the low-water line, but not sufficiently to cause rupture. The appearance of the breaks and the settling of the revetment in places, together with the apparently undisturbed condition of the subaqueous mats at some distance from the shore, and opposite the disturbed portions, indicated that ruptures first occurred near the low-water line, probably at about the junction of the subaqueous and upper bank work. The cause of the rupture can only be ascribed to the scour of material from beneath the mats, thus allowing them to settle and finally to break up. Where the material of the bank was fine, a rapid current would wash it out through the

many larger openings which were present in this type of mat work, and to prevent this the structure must be made closer. Borings made along this bank indicate that in many places strata of fine sand exist near the low-water line, and soundings taken on numerous sections along this bank, when compared with previous soundings along the same sections, showed a settling of the mat work and that this settling was greater near the low-water line.

While it is probable that all of the breaks occurred in the manner described, it is possible that undermining from the outer edge may have aided in making the large breaks where no subaqueous mats could be found. This subaqueous work was 196 feet wide; the portion built in 1887 reached nearly to deep water, as the mats were sunk during low stage of the river, but the work of 1888 was placed at a much higher stage, and, consequently, the subaqueous mattress did not reach to the foot of the slope, being probably from 50 to 100 feet too narrow.

It was therefore considered advisable in repairing the damaged revetment to increase the width of the mats to 240 feet, to make the connecting mats thicker by placing an additional layer of brush on them, to extend these mats a sufficient distance on the bank to insure a good connection with the paving, and to place under the stone paving a layer of broken stone or quarry spalls, so that scour could not occur through the stone by the action of wind or steamboat waves. In some locations this action had caused the paving of the previous year to settle. The construction of the mats was practically the same as heretofore.

In this season all the intervals left in the 1887 work after the repairs of 1891 were covered with subaqueous mats, and 1,470 feet of subaqueous mat was placed along the 1888 work. The other breaks, being minor in extent, with the river mats in place as determined by the soundings, were covered with wide connecting mats, and these were also placed in all pockets and other localities where necessary to properly join the paving and subaqueous work. The upper bank was graded to about the 24-foot stage, above which was left an almost vertical bench of generally compact clay from 6 to 8 feet thick and which it was supposed would not be eroded by the current. The paving was placed on the slope up to this bench and had a base of from 3 to 4 inches of broken stone, on which was placed from 6 to 7 inches thick of closely pitched riprap.

The work done this season was as follows: River mats placed along 3,420 linear feet of bank, connecting mats placed along 6,200

linear feet, paving 4,970 linear feet of bank, covering 34,667 square yards, and in addition 6,555 square yards of old bank mat was re-covered with stone 6 inches thick.

With the completion of the work of this season the revetment of 1887 and 1888 had been rebuilt, except two pieces of subaqueous work: the upper of them, 1,900 feet long, extended from the foot of the 1850 work to the head of the lower mat placed this year, and the other, 900 feet long, was between the lower end of the same mat and Hopefield Point.

The high water of 1893 breached both blocks of the remaining 1888 work, the caving along the upper block extending its entire length, and along the lower block for a length of 500 feet from the upper end and extending 75 feet back into the bank. At a number of places the revetment had also settled along the low-water line. For some years past the current along the locality where these breaks occurred had been exceedingly strong, reaching at times a maximum of about 8 miles per hour, and as the original work had failed with each succeeding high water it was demonstrated that some change must be made in the construction of the mats, for while the diagonally woven mats could stand currents of moderately high velocity, there was a limit beyond which they would fail, no matter what care was taken in their construction, and as it was practically proven that the failure was frequently caused by the scour of the material from beneath and through the interstices of the mat it was evident that if this bank was to be held this scour must be prevented; hence a more compact type of mattress was designed, consisting of brush made into fascines, which were closely and firmly joined together like the woof of a carpet by using strong wire strands for the warps. This type of mattress was first tried in a crude and experimental form at Plum Point in 1892. The fascine mattress was afterwards adopted as the standard type for subaqueous protection, but as its adoption marks an important stage in the development of bank revetment it will be described later under a separate heading. The early work done at Memphis between 1878 and 1882 and its failure in the 1884 flood and the reasons for this failure have all been discussed. Work was resumed in 1884 and continued in 1886 and 1887, and resulted in the renewal of all the old work with a revetment designed to remedy the defects developed by experience in this old work and its extension to and from 1,200 feet above the mouth of Wolf River to Beal street, a total distance of 7,700 feet. No fail-



ures had occurred in this work up to 1892, and, in fact, none have since. The work at Hopefield was not so fortunate. Failures in the work were continually occurring, and each year it was necessary to replace a good deal of previous work, and in spite of increased strength and improved character of the work put in loss continued, so that after the flood of 1893 practically none of the work done prior to 1890 was left in an efficient condition. The causes of these failures will now be briefly discussed.

#### CAUSES OF FAILURE

During the first few years of the work at Memphis and Hopefield losses during construction were met with. But based upon this experience changes and alterations were made, and by increasing the strength of the mats, both longitudinally and transversely, by strengthening the moorings and increased skill in handling and sinking the mats, and by avoiding work under the most unfavorable conditions all such trouble was avoided, and during the last five or six years no losses occurred during construction.

The causes of failure of the mat after it was put in place have been mentioned from time to time. Those affecting the subaqueous work were mainly insufficient widths of the mats, and the liability to scour through them. The former allowed scour to take place under the outer edge of the mat and the latter under any part of the mat where the local current was strong enough and the soil erodable. The steps successively taken to prevent damage from these causes have been related, a gradual increase in the width of mattresses from 140 to 300 feet, and the gradual alteration in the type of mattress from the single woven mat to the double diagonal system, and, finally, to the fascine mattress.

A good many of the failures were due, initially, to trouble with the upper bank. In 1883 the subaqueous work was hurried ahead, and the upper bank parties being unable to keep up, the end of the season found 4,250 feet of bank protected below low water, but bare above. It was thought at the time that these mats alone would be sufficient to arrest caving due to one high water or that the upper bank would cave so little that it could be covered the next season and this covering connected with the mats. But this expectation was not realized, for this entire length was lost, while the part where the upper bank work had been placed was but slightly damaged. This one fact shows how greatly the conditions met with here differed from those in other rivers. In the Mississippi below

St. Louis it was then, and is still, the custom to avoid the expense of grading the bank by placing during the first season a subaqueous work only; after a year or two the river itself would have graded the bank part of the way up. This is then revetted, and after a few years the bank still higher up is completed, and so on. Here at Hopefield, however, a single high water cut into the unprotected upper bank, undermined the mat from the inside, and destroyed so much of the bank that the new low-water line was in places 500 feet away from the old, there being 50 and 60 feet of water where the bank had been the year before. Even after this upper bank work was in place, failures occurred in it; some due to its not extending high enough up the bank and others to deterioration from decay. As a precaution against the latter trouble stone was substituted for the brush used. But with the stone and where the soil was sandy it was found that scour would occur at and near the water surface on account of the sand being sucked out through the stone by wave action. To prevent this, the surface was first closely paved with a layer of spalls or crushed rock, and the latter was prevented from moving by being weighted down with large stone.

Another locality of trouble was just at about the low-water line, due to the settling of the subaqueous work and the resulting rupture of the connection between the river and bank work; this would leave an unprotected belt subject to erosion, and, this once eroded, the undermining of the upper bank quickly followed. Nor was the attempt to make the river, connecting, and shore mats all in one piece successful, for even in this case the inevitable settlement meant a rupture of the mat. In some cases, where the rupture did not take place, the undermining of the river work allowed the bank itself, with all the revetment work on it, to slide down to deeper water; in fact, it was not until the scour itself and the resulting settlement was prevented by making the subaqueous work wider and impervious enough that trouble along the low-water line was avoided.

#### RESULTS

The object of the work along the Memphis front was to stop the caving of the bank at that point, and this object was successfully effected, but in addition to protecting the Memphis front from caving the original project for work in Memphis Harbor contemplated the preservation of the bank along Hopefield Bend, in such shape as to prevent the river from leaving the Memphis front, which it was feared would be the result if the continuous caving at Hope-

field was not soon checked. With this object in view, the work of revetting the banks at the latter locality was begun late in 1882. The opinion at the time was that the entire length of the bend, or about 3 miles, would be revetted within two years' time, and if this had been done and the bank line successfully held it would have resulted in great benefit to the harbor of Memphis. But instead of accomplishing the work in two years delays occurred, and it was not until 1888 that the entire length of the bend was revetted, and not until Hopefield Point had receded by about 3,000 feet; and as a result of this the protection of the Memphis wharf front, the real object of the Hopefield work, was only in part effected.

On the map (Plate L) will be seen the location of the bank line as it caved from year to year and the location of the work constructed from time to time.

As will be seen, all of the original work of 1882 was lost, its site having been covered by the repair work of later years. The 1883 revetment was carried to within 3,600 feet of the Point, or to a distance of 10,600 feet from the initial point, but the lower 4,250 feet of this consisted of only a light subaqueous mat. It was at the time thought that the mat alone would be sufficient to arrest caving during one high water, but this expectation was not realized, for the entire lower part of the work was lost, so after the recession of the high water of 1884 the length of bank held by the revetments was but 6,300 feet, leaving 8,000 feet to be constructed to carry it to the Point. In 1884, in addition to repairs to existing revetments, 3,300 linear feet of new work was added, extending the revetment to 9,600 feet from the initial point, or 4,700 feet short of Hopefield Point.

This Point had caved considerably during the previous high water, but had left the bend in such shape that the flow of the river from it struck along the upper portion of the Memphis front. If, therefore, Hopefield Bend could have been held on the line of that year, it would have effectively preserved the entire river front of Memphis, but owing to the extensive work then in progress at the latter place, and which required the use of most of the available plant, the completion of the Hopefield work was delayed, with the intention of executing it the following year, and in spite of still further caving it is possible that if the bank could have been held on the 1885 line the Memphis front might still have been preserved, but the failure of the river and harbor bill in that year prevented this.

Owing to trouble over the clause prohibiting bank protection, it was not until 1887 that work could be resumed, and in the meantime the Point had still further receded and 1,500 feet of the lower end of the 1884 work had been lost. So many repairs were necessary to the older work this year and the distance to the Point on the new line was so increased that even at the end of this season, and in spite of the 4,000 feet of new work, there still remained 4,500 feet unrevetted. In 1888 additional caving occurred. Hopefield Bend had now receded about 3,000 feet from the 1882 line, and all chances of effectually preserving the Memphis wharf front had vanished.

In the fall of this year the Hopefield revetment was extended to the Point, a distance of 4,500 feet, thus completing the project made in 1882. The entire length of the revetment was 16,600 feet and had required six years to complete, instead of two years, as at first estimated. Along this 1888 line Hopefield Bend has since been held with no loss of importance, and thus, though the entire bend has been and is still effectively revetted, yet the object of the revetment has been only in part accomplished.

*Memphis Sand Bar.*—(Plate XXXVII.) On the Memphis side in 1884 the current was so strong along the whole front from above Wolf River to below the city that all the early work was destroyed and had to be renewed. Could Hopefield Bend have been held in the location of that year, deep water would have been insured along the Memphis front. In 1885 the point of attack against the Memphis bank had moved some distance downstream, and in 1886 farther still. The current that now left Hopefield Point tangentially though drawn around the Point somewhat, still impinged nearly perpendicularly against the city front. This, and the large and open space above, caused the formation of a pressure eddy, the current in which started near the foot of Market street and flowed slowly upstream until above the mouth of Wolf River, where it turned outwardly and was absorbed in the main flow of the river. Throughout this eddy the current was slack and a deposit was steadily going on, and even had no further caving occurred at Hopefield the upper part of the city front must have soon filled up.

During the high water of 1887 the bank caving at Hopefield Bend continued and an additional 600 feet of the Point was lost. This caused the crossing to drop still farther downstream and extended the eddy and its slack water to about Washington street, producing a large eddy and extensive shoaling over the territory which it



covered, and it was now evident that the recession of Hopefield Point had become too great to prevent the formation of a bar along the upper portion of the Memphis front.

The high water of 1888 caused additional caving at Hopefield Point to the extent of about 400 feet and a resultant increase in the area of the eddy along the Memphis front, which now extended from the foot of Old Hen Island to below Court street, and had a width of over 2,000 feet at Wolf River. Some observations made in April, 1888, with the river at the 34-foot stage, showed that it required about thirty-five minutes to fill and empty the eddy; while it was filling, the flow of the current along the shore was upstream, and while emptying it was reversed and the elevation of the water changed about one-half a foot between the ebb and flow. The deposits this year were exceedingly great and reached to above the zero stage of the Memphis gage at two places, one about a quarter mile above and the other just opposite the mouth of Wolf River. It was during the latter part of this year that the revetment work finally reached Hopefield Point, but though the caving of this Point was then finally stopped, the growth of the sand bar continued for some years.

The high water of 1889 brought the bar well above the low-water plane from Old Hen Island to the foot of Poplar street. Its crest was about 800 feet from the main bank and nearly parallel to it and had a maximum elevation of 11 feet, except where Wolf River had scoured a channel through it immediately in front of its mouth. This channel was of insufficient depth at low water for the boats navigating Wolf River, so it was then dredged by the steamboat owners. Between the bar and the main shore there was a depression, which at its highest point was only 2 feet above low water. This highest part of the depression was a short distance above Market street, so during this year the sand bar became attached to the main bank at low water. During the low water of this season the steamboats landed along the Elevator, just below Poplar street, but the coal fleet, which for years had occupied the front immediately above, was obliged to change its landing place.

The flood of 1890 greatly enlarged the bar, increasing its height to 15 feet, its width at Wolf River to 1,600 feet, and tailing it down to within 150 feet of Jefferson street. It became at low water attached to the main shore from Wolf River nearly to Poplar street. Below this and along the main bank down to Jefferson street there was barely sufficient water at low-water stage to afford navigation

to the Elevator, and the Government had to do a small amount of dredging to secure the navigability of this channel.

In 1891 the bar had tailed downstream to 300 feet below Jefferson street, had increased to 1,800 feet in width at Wolf River, and while the maximum height had not increased there was considerable increase in the average height. The channel to the Elevator had silted up considerably and required 55,000 cubic yards of excavation, to be done by the Government, in order to afford navigation to the Elevator Landing. Even when this was done only a few steamboats used it, and after this year it was entirely abandoned.

By 1892 the Memphis bar extended to nearly opposite Court street, and while the width at Wolf River had not increased, the bar was considerably widened along the lower portion, the increase being 600 feet at Jefferson street. In height the bar had built up to a maximum elevation of 21 feet opposite Adams street. Along the bank of Wolf River it was 10 feet high, and at the former depression above Poplar street 13 feet, while the bottom of the old steamboat channel had risen to the 6-foot stage. Thus in three years from the first appearance of the dry bar the entire river front above Court street had been rendered inaccessible to steamboats at ordinary low stages, and the area exposed at low water was 80 acres.

Since 1892 there has been practically no loss of bank line at Hopefield, but the Memphis sand bar has continued to increase its dimensions, and has now (1901) an area of about 106 acres, with a width of about 2,300 feet at Wolf River, a maximum height of 28 feet above the zero of the Memphis gage, and has tailed down nearly to Union street. Since 1896 there has been no increase in length, and while the width along the upper portion has somewhat increased, this has remained unchanged along the lower portion, and as the face of the bar is quite steep to deep water, it is probable that it has attained nearly its maximum area.

The question of removing the bar for the restoration of the harbor has been frequently discussed and various methods have been suggested. The river and harbor act of March 3, 1899, provided that—

The Mississippi River Commission is directed to examine the harbor at Memphis, Tenn., and report what improvement, if any, should be made to remove the bar in front of the city of Memphis, together with the cost thereof.

The report which the Commission made on this subject is to be found in the Report of the Chief of Engineers for 1899, page 3292.

The conclusion arrived at was that it was impracticable to remove the bar, but that it should be prevented from enlarging in area by holding Hopefield Point at its present location, that the growth of the bar in height should be encouraged, and that the bar would then be very useful and valuable, and that even at its present height it could be utilized by the city for wharfage purposes when supplemented by proper structures. It was stated that when the bar had shown that it had reached its maximum size it might be well to maintain it by revetting its front.

Had it not been for the failure of the river and harbor act of 1885 and the clause in the act of 1886 prohibiting bank revetment, there is no doubt that the revetment at Hopefield would have been finally held on lines that would have trained the river along the Memphis front in such a manner as to have prevented any detrimental deposits below Wolf River, and the harbor would thus have been preserved in accordance with the original design.

The cost of the above described revetment in Memphis Harbor between 1882 and 1892 was: At Hopefield, about \$836,000; at Memphis, about \$254,000, but of this about \$20,000 was expended in dredging the channel behind the sand bar in 1890 and 1891.

As a further illustration of the work in Memphis Harbor during this period, see photograph No. 8, which is printed on page 137.

**Document 6**

**AN ACT FOR THE CONTROL OF FLOODS  
ON THE MISSISSIPPI RIVER AND ITS TRIBUTARIES,  
AND FOR OTHER PURPOSES**

Public Law No. 391, 70th Congress  
33 U. S. C., sec. 702a  
Approved May 15, 1928

*Laws of the United States  
Relating to the Improvement of Rivers and Harbors  
from August 11, 1970 to January 2, 1939  
Volume III, House Document No. 379, 76th Cong. 1st Sess.  
(Washington: Government Printing Office, 1940), pp. 1004-10.*



May 15, 1928.  
[S. 3740.]  
[Public, No. 391.  
Vol. 45, p. 534.]

CHAP. 569.—An Act For the control of floods on the Mississippi River and its tributaries, and for other purposes.

Floods on Mississippi River, etc.  
Engineering plan of Chief of Engineers for control of, etc., adopted and authorized to be prosecuted.

*Provisos.*  
Board created, composition.

Differences between adopted project and plans of Mississippi River Commission to be considered by.

Decision of the President on recommendations of Board to be followed.

Limit on power of board.

Execution of project by Mississippi River Commission.  
*Post 537.*

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the project for the flood control of the Mississippi River in its alluvial valley and for its improvement from the Head of Passes to Cape Girardeau, Missouri, in accordance with the engineering plan set forth and recommended in the report submitted by the Chief of Engineers to the Secretary of War dated December 1, 1927, and printed in House Document Numbered 90, Seventieth Congress, first session, is hereby adopted and authorized to be prosecuted under the direction of the Secretary of War and the supervision of the Chief of Engineers: *Provided*, That a board to consist of the Chief of Engineers, the president of the Mississippi River Commission, and a civil engineer chosen from civil life to be appointed by the President, by and with the advice and consent of the Senate, whose compensation shall be fixed by the President and be paid out of the appropriations made to carry on this project, is hereby created; and such board is authorized and directed to consider the engineering differences between the adopted project and the plans recommended by the Mississippi River Commission in its special report dated November 28, 1927, and after such study and such further surveys as may be necessary, to recommend to the President such action as it may deem necessary to be taken in respect to such engineering differences and the decision of the President upon all recommendations or questions submitted to him by such board shall be followed in carrying out the project herein adopted. The board shall not have any power or authority in respect to such project except as hereinbefore provided. Such project and the changes therein, if any, shall be executed in accordance with the provisions of section 8 of this Act. Such surveys shall be made between Baton Rouge, Louisiana, and Cape

Girardeau, Missouri, as the board may deem necessary to enable it to ascertain and determine the best method of securing flood relief in addition to levees, before any flood-control works other than levees and revetments are undertaken on that portion of the river: *Provided*, That all diversion works and outlets constructed under the provisions of this Act shall be built in a manner and of a character which will fully and amply protect the adjacent lands: *Provided further*, That pending completion of any floodway, spillway, or diversion channel, the areas within the same shall be given the same degree of protection as is afforded by levees on the west side of the river contiguous to the levee at the head of said floodway, but nothing herein shall prevent, postpone, delay, or in anywise interfere with the execution of that part of the project on the east side of the river, including raising, strengthening, and enlarging the levees on the east side of the river. The sum of \$325,000,000 is hereby authorized to be appropriated for this purpose.

All unexpended balances of appropriations heretofore made for prosecuting work of flood control on the Mississippi River in accordance with the provisions of the Flood Control Acts approved March 1, 1917, and March 4, 1923, are hereby made available for expenditure under the provisions of this Act, except section 13.

SEC. 2. That it is hereby declared to be the sense of Congress that the principle of local contribution toward the cost of flood-control work, which has been incorporated in all previous national legislation on the subject, is sound, as recognizing the special interest of the local population in its own protection, and as a means of preventing inordinate requests for unjustified items of work having no material national interest. As a full compliance with this principle in view of the great expenditure estimated at approximately \$292,000,000, heretofore made by the local interests in the alluvial valley of the Mississippi River for protection against the floods of that river; in view of the extent of national concern in the control of these floods in the interests of national prosperity, the flow of interstate commerce, and the movement of the United States mails; and, in view of the gigantic scale of the project, involving flood waters of a volume and flowing from a drainage area largely outside the States most affected, and far exceeding those of any other river in the United States, no local contribution to the project herein adopted is required.

SEC. 3. Except when authorized by the Secretary of War upon the recommendation of the Chief of Engineers, no money appropriated under authority of this Act shall be expended on the construction of any item of the project until the States or levee districts have given assurances satisfactory to the Secretary of War that they

Surveys, between Baton Rouge, La., and Cape Girardeau before undertaking flood control other than levees. Protection of adjacent lands by diversion works, etc.

Areas within floodways, etc., to be protected pending completion.

No interference with project on east side of the river.

Sum authorized to be appropriated.

*Post*, p. 930.

Unexpended balances for Mississippi River flood control available.

Vol. 39, p. 948;

Vol. 42, p. 1505.

Exception.

*Post*, p. 539.

Local contribution toward cost of flood control declared a sound principle.

Considerations for not requiring it for adopted project.

Great expenditures heretofore made by local interests, national concern in control of the flood, gigantic scale of the project, etc.

Assurances required of States, etc., before expenditure on any item of the project.

# LAWS RELATING TO IMPROVEMENT OF RIVERS AND HARBORS

Maintain flood-control works after completion.

Accept lands turned over to them.

Provide right of way for levees, etc., on main river from Cape Girardeau to Head of Passes.

No Federal liability for flood damages.

*Proviso.*

Land or flowage rights to be acquired where levees not practicable, and lands subject to overflow, but are not now subject thereto by levees on opposite bank.

Flowage rights for additional flood waters caused by diverting main river channel.

*Proviso.*

Consideration of resulting benefits.

Proceedings in district courts to condemn lands needed for project.

Assessment of value.

Purchase from owner fixing a reasonable price.

Donations accepted.

will (a) maintain all flood-control works after their completion, except controlling and regulating spillway structures, including special relief levees; maintenance includes normally such matter as cutting grass, removal of weeds, local drainage, and minor repairs of main river levees; (b) agree to accept land turned over to them under the provisions of section 4; (c) provide without cost to the United States, all rights of way for levee foundations and levees on the main stem of the Mississippi River between Cape Girardeau, Missouri, and the Head of Passes.

No liability of any kind shall attach to or rest upon the United States for any damage from or by floods or flood waters at any place: *Provided, however,* That if in carrying out the purposes of this Act it shall be found that upon any stretch of the banks of the Mississippi River it is impracticable to construct levees, either because such construction is not economically justified or because such construction would unreasonably restrict the flood channel, and lands in such stretch of the river are subjected to overflow and damage which are not now overflowed or damaged by reason of the construction of levees on the opposite banks of the river it shall be the duty of the Secretary of War and the Chief of Engineers to institute proceedings on behalf of the United States Government to acquire either the absolute ownership of the lands so subjected to overflow and damage or flood-age rights over such lands.

SEC. 4. The United States shall provide flowage rights for additional destructive flood waters that will pass by reason of diversions from the main channel of the Mississippi River: *Provided,* That in all cases where the execution of the flood-control plan herein adopted results in benefits to property such benefits shall be taken into consideration by way of reducing the amount of compensation to be paid.

The Secretary of War may cause proceedings to be instituted for the acquirement by condemnation of any lands, easements, or rights of way which, in the opinion of the Secretary of War and the Chief of Engineers, are needed in carrying out this project, the said proceedings to be instituted in the United States district court for the district in which the land, easement, or right of way is located. In all such proceedings the court, for the purpose of ascertaining the value of the property and assessing the compensation to be paid, shall appoint three commissioners, whose award, when confirmed by the court, shall be final. When the owner of any land, easement, or right of way shall fix a price for the same which, in the opinion of the Secretary of War is reasonable, he may purchase the same at such price; and the Secretary of War is also authorized to accept donations of lands, easements, and rights of way required for this

project. The provisions of sections 5 and 6 of the River and Harbor Act of July 18, 1918, are hereby made applicable to the acquisition of lands, easements, or rights of way needed for works of flood control: *Provided*, That any land acquired under the provisions of this section shall be turned over without cost to the ownership of States or local interests.

Condemnation procedure.  
Vol. 40, p. 911.

*Proviso.*  
Acquired land given to ownership of States, etc.

Mapping agencies to assist in preparing necessary maps.

Payment for services.

SEC. 5. Subject to the approval of the heads of the several executive departments concerned, the Secretary of War, on the recommendation of the Chief of Engineers, may engage the services and assistance of the Coast and Geodetic Survey, the Geological Survey, or other mapping agencies of the Government, in the preparation of maps required in furtherance of this project, and funds to pay for such services may be allotted from appropriations made under authority of this Act.

Application of funds for flood work heretofore authorized, and not included on present project.

SEC. 6. Funds appropriated under authority of section 1 of this Act may be expended for the prosecution of such works for the control of the floods of the Mississippi River as have heretofore been authorized and are not included in the present project, including levee work on the Mississippi River between Rock Island, Illinois, and Cape Girardeau, Missouri, and on the outlets and tributaries of the Mississippi River between Rock Island and Head of Passes in so far as such outlets or tributaries are affected by the backwaters of the Mississippi: *Provided*, That such work on the Mississippi River between Rock Island, Illinois, and Cape Girardeau, Missouri, and on such tributaries; the States or levee districts shall provide rights of way without cost to the United States, contribute 33½ per centum of the costs of the works, and maintain them after completion: *And provided further*, That not more than \$10,000,000 of the sums authorized in section 1 of this Act, shall be expended under the provisions of this section.

Levees specified.

*Provisos.*  
Share in costs of rights of way, etc., by States, etc., between Rock Island and Cape Girardeau, etc.

Expenditure limited.

In an emergency, funds appropriated under authority of section 1 of this Act may be expended for the maintenance of any levee when it is demonstrated to the satisfaction of the Secretary of War that the levee can not be adequately maintained by the State or levee district.

Funds in emergency for maintenance of a levee, if State, etc., unable to do so.

SEC. 7. That the sum of \$5,000,000 is authorized to be appropriated as an emergency fund to be allotted by the Secretary of War on the recommendation of the Chief of Engineers, in rescue work or in the repair or maintenance of any flood-control work on any tributaries of the Mississippi River threatened or destroyed by flood including the flood of 1927.

Emergency fund authorized in rescue work, etc., on tributaries subject to flood.  
Post, p. 930.

SEC. 8. The project herein authorized shall be prosecuted by the Mississippi River Commission under the direction of the Secretary of War and supervision of the Chief of Engineers and subject to the provisions of this Act. It shall perform such functions and through such agencies as they shall designate after consultation and

Mississippi River Commission to prosecute project.



discussion with the president of the commission. For all other purposes the existing laws governing the constitution and activities of the commission shall remain unchanged. The commission shall make inspection trips of such frequency and duration as will enable it to acquire first-hand information as to conditions and problems germane to the matter of flood control within the area of its jurisdiction; and on such trips of inspection ample opportunity for hearings and suggestions shall be afforded persons affected by or interested in such problems. The president of the commission shall be the executive officer thereof and shall have the qualifications now prescribed by law for the Assistant Chief of Engineers, shall have the title brigadier general, Corps of Engineers, and shall have the rank, pay, and allowances of a brigadier general while actually assigned to such duty: *Provided*, That the present incumbent of the office may be appointed a brigadier general of the Army, retired, and shall be eligible for the position of president of the commission if recalled to active service by the President under the provisions of existing law.

Inspection trips by, to acquire information of conditions and flood control problems, etc.

Title, rank, etc., of president as executive officer.

*Proviso.* Appointment in Army of present president.

Salaries.

Deduction of official salary from amount fixed herewith.

Application of navigable waters, restrictions and penalties. Vol. 30, pp. 1152, 1153.

Surveys previously authorized of the Mississippi and tributaries to be speedily prosecuted. Vol. 44, p. 1015.

Projects for flood control on all tributary streams to be submitted.

Rivers, etc., specified.

The salary of the president of the Mississippi River Commission shall hereafter be \$10,000 per annum, and the salary of the other members of the commission shall hereafter be \$7,500 per annum. The official salary of any officer of the United States Army or other branch of the Government appointed or employed under this Act shall be deducted from the amount of salary or compensation provided by, or which shall be fixed under, the terms of this Act.

SEC. 9. The provisions of sections 13, 14, 16, and 17 of the River and Harbor Act of March 3, 1899, are hereby made applicable to all lands, waters, easements, and other property and rights acquired or constructed under the provisions of this Act.

SEC. 10. That it is the sense of Congress that the surveys of the Mississippi River and its tributaries, authorized pursuant to the Act of January 21, 1927, and House Document Numbered 308, Sixty-ninth Congress, first session, be prosecuted as speedily as practicable, and the Secretary of War, through the Corps of Engineers, United States Army, is directed to prepare and submit to Congress at the earliest practicable date projects for flood control on all tributary streams of the Mississippi River system subject to destructive floods which projects shall include: The Red River and tributaries, the Yazoo River and tributaries, the White River and tributaries, the Saint Francis River and tributaries, the Arkansas River and tributaries, the Ohio

# LAWS RELATING TO IMPROVEMENT OF RIVERS AND HARBORS

River and tributaries, the Missouri River and tributaries, and the Illinois River and tributaries; and the reports thereon, in addition to the surveys provided by said House Document 308, Sixty-ninth Congress, first session, shall include the effect on the subject of further flood control of the lower Mississippi River to be attained through the control of the flood waters in the drainage basins of the tributaries by the establishment of a reservoir system; the benefits that will accrue to navigation and agriculture from the prevention of erosion and siltage entering the stream; a determination of the capacity of the soils of the district to receive and hold waters from such reservoirs; the prospective income from the disposal of reservoir waters; the extent to which reservoir waters may be made available for public and private uses; and inquiry as to the return flow of waters placed in the soils from reservoirs, and as to their stabilizing effect on stream flow as a means of preventing erosion, siltage, and improving navigation: *Provided*, That before transmitting such reports to Congress the same shall be presented to the Mississippi River Commission, and its conclusions and recommendations thereon shall be transmitted to Congress by the Secretary of War with his report.

Reports to include effect of further flood control of the lower Mississippi, etc., by establishing reservoir systems in drainage basins of the tributaries.

*Proviso.*  
Reports to be transmitted to Congress with conclusions, etc., of Commission thereon.

Additional sum authorized for preparing these projects.

The sum of \$5,000,000 is hereby authorized to be used out of the appropriation herein authorized in section 1 of this Act, in addition to amounts authorized in the River and Harbor Act of January 21, 1927, to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers for the preparation of the flood-control projects authorized to be submitted to Congress under this section: *Provided further*, That the flood surveys herein provided for shall be made simultaneously with the flood-control work on the Mississippi River provided for in this Act: *And provided further*, That the President shall proceed to ascertain through the Secretary of Agriculture and such other agencies as he may deem proper, the extent to and manner in which the floods in the Mississippi Valley may be controlled by proper forestry practice.

*Provisos.*  
Surveys simultaneously with flood control projects.

Extent, etc., of forestry practice on flood control to be ascertained.

SEC. 11. That the Secretary of War shall cause the Mississippi River Commission to make an examination and survey of the Mississippi River below Cape Girardeau, Missouri, (a) at places where levees have heretofore been constructed on one side of the river and the lands on the opposite side have been thereby subjected to greater overflow, and where, without unreasonably restricting the flood channel, levees can be constructed to reduce the extent of this overflow, and where the construction of such levees is economically justified, and report thereon to the Congress as soon as practicable

Survey, etc., of the Mississippi below Cape Girardeau.

To report on constructing levees to protect lands subject to greater overflow by levees on opposite side of the river.

# LAWS RELATING TO IMPROVEMENT OF RIVERS AND HARBORS

To determine, etc., effect on lands between river and adjacent hills by overflow caused by levees at other points.

*Proviso.*  
Resurvey for levee from Tiptonville to the Obion River in Tennessee.

If feasible, to be built.

Inconsistent laws repealed.

Sacramento River, Calif.  
Project for flood control of, modified.  
Vol. 39, p. 948.

*Proviso.*  
Total amounts restricted.

Interest of Members of Congress in acquisition of lands, prohibited.  
R. S., sec. 3741, p. 737.  
U. S. Code, p. 1310.

with such recommendations as the commission may deem advisable; (b) with a view to determining the estimated effects, if any, upon lands lying between the river and adjacent hills by reason of overflow of such lands caused by the construction of levees at other points along the Mississippi River, and determining the equities of the owners of such lands and the value of the same, and the commission shall report thereon to the Congress as soon as practicable with such recommendation as it may deem advisable: *Provided*, That inasmuch as the Mississippi River Commission made a report on the 26th day of October, 1912, recommending a levee to be built from Tiptonville, Tennessee, to the Obion River in Tennessee, the said Mississippi River Commission is authorized to make a resurvey of said proposed levee and a relocation of the same if necessary, and if such levee is found feasible, and is approved by the board created in section 1 of this Act, and by the President the same shall be built out of appropriations hereafter to be made.

SEC. 12. All laws or parts of laws inconsistent with the above are hereby repealed.

SEC. 13. That the project for the control of floods in the Sacramento River, California, adopted by section 2 of the Act approved March 1, 1917, entitled "An Act to provide for the control of the floods of the Mississippi River and of the Sacramento River, California, and for other purposes," is hereby modified in accordance with the report of the California Débris Commission submitted in Senate Document Numbered 23, Sixty-ninth Congress, first session: *Provided*, That the total amounts contributed by the Federal Government, including the amounts heretofore contributed by it, shall in no event exceed in the aggregate \$17,600,000.

SEC. 14. In every contract or agreement to be made or entered into for the acquisition of land either by private sale or condemnation as in this Act provided the provisions contained in section 3741 of the Revised Statutes being section 22 of title 41 of the United States Code shall be applicable.

Approved, May 15, 1928.

## **Part III**

# **CHRONOLOGY**





## CHRONOLOGY

- 1822—Brigadier General Simon Bernard and Brevet Lieutenant Colonel Joseph G. Totten submit their report on the improvement of navigation on the Ohio and Mississippi Rivers.
- 1824—Gibbons v. Ogden decision. The United States Supreme Court says that the federal government's power to regulate interstate commerce includes the power to regulate river navigation "so far as that navigation may be in any manner connected with commerce."  
—General Survey Act. Congress authorizes the President to employ civil engineers and officers of the Corps of Engineers to make surveys, plans, and estimates for "routes of such roads and canals as he may deem of national importance."  
—Congress passes "An Act To improve the navigation of the Ohio and Mississippi Rivers."
- 1826—Henry M. Shreve appointed Superintendent of Western River Improvements.
- 1829—Shreve's steam snagboat, the *Heliopolis*, is launched by the Corps of Engineers.
- 1834—First steamboat line established at Memphis.
- 1845—John C. Calhoun speaks on behalf of appropriations for the improvement of the Mississippi at a river convention held in Memphis.
- 1849—In both years Congress passes a Swamp Land Act, which transfers  
-50 "swamp and overflowed" lands to states in the Mississippi delta on condition that the funds obtained from selling the lands be used for levees and drainage ditches.
- 1850—Congress appropriates \$50,000 for a topographical and hydrographical survey of the Mississippi delta.
- 1851—Charles S. Ellet, Jr., submits his report on the Mississippi delta in which he recommends reservoirs on the Mississippi's tributaries to help prevent flooding.
- 1858—Floods in these years devastate the St. Francis levee system.  
-59
- 1861—Captain Andrew A. Humphreys and Lieutenant Henry L. Abbot submit their *Report Upon the Physics and Hydraulics of the Mississippi River*, one of the most significant American contributions to nineteenth century hydraulic engineering.
- 1866—Humphreys submits his report on the war-damaged levees along the lower Mississippi. He does not recommend federal assistance to rebuild the levees protecting the St. Francis bottomland.  
—Congress authorizes the Secretary of the Navy to transfer to the Secretary of War portions of the Mississippi River fleet to help in raising snags and removing obstructions in the western rivers.

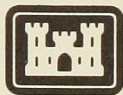
- 1867—Congress appropriates \$200,000 to improve the mouth of the Mississippi.
- 1868—Congress appropriates \$40,000 for Mississippi River improvements.
- 1871—Responding to Lieutenant Colonel William F. Raynold's recommendation, Congress appropriates \$10,000 for clearing and snagging operations on the St. Francis River.
- 1874—Congress authorizes a new survey of the lower Mississippi from Cairo to New Orleans. Major Charles R. Suter conducts the survey.
- The President of the United States establishes a commission of three Army Engineers and two civil engineers to study the best system for the "permanent reclamation and redemption" of the alluvial basin of the Mississippi River.
- 1878—Brigadier General Andrew A. Humphreys, Chief of Engineers, establishes a board to consider the best means to improve low-water navigation of the Mississippi and Missouri Rivers.
- 1879—Mississippi River Commission established. Boards created in 1878 and 1874 are terminated.
- 1882—Major flood on the lower Mississippi devastates local levee systems, creating 284 crevasses totaling 56 miles in length.
- Mississippi River Commission reorganizes. The U.S. Army Corps of Engineers becomes responsible for implementing the commission's plans. The commission divides the Mississippi below Cairo into four administrative districts, each one supervised by a Corps of Engineers officer. The First, Second, Third, and Fourth Districts are headquartered, respectively, in Cairo, Memphis, Vicksburg, and New Orleans.
  - In the 1882 Rivers and Harbors Act, Congress appropriates \$4 million for improvements on the Mississippi, including Memphis harbor.
- 1884—A major flood delays work on Memphis Harbor.
- The American Red Cross becomes involved in its first flood fight.
  - Congress appropriates \$200,000 to protect Memphis Harbor.
- 1885—First District headquarters moves from Cairo to Memphis.
- 1890—First and Second Districts consolidate under one officer, known as the District Engineer for the First and Second Mississippi River Commission Districts.
- Major flood on the Lower Mississippi creates 23 crevasses in levee lines. The Mississippi River Commission decides that the 1890 flow line should be the line of reference for levee grades.
- 1891—Representatives of steamship companies operating below St. Louis express concerns to the Mississippi River Commission about low-water navigation on the Mississippi.
- 1892—The Mississippi River Commission allocates funds for levee construction in the lower St. Francis basin.

- 1893—The Arkansas General Assembly incorporates the St. Francis Levee District. Congress appropriates \$75,000 to construct a levee from Kents Mound to Wheel Ridge in Lee County, Arkansas, a distance of six miles, to prevent the Mississippi from cutting through to the St. Francis at Walnut Bend.
- 1894—The hydraulic dredge *Alpha* completes successful tests at Cape Girardeau, Missouri.
- 1896—The hydraulic dredge *Beta* is launched.  
—Congress authorizes the construction of dredges “with the view of ultimately obtaining and maintaining a navigable channel from Cairo down, not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year except when navigation is closed by ice.” In response, the Mississippi River Commission creates an independent Dredging District at St. Louis. The District’s plant and equipment are later transferred to West Memphis, Arkansas.
- 1897—A disastrous flood inundates most of Mississippi, Poinsett, St. Francis, Cross, Crittenden, and Lee counties in Arkansas.
- 1901—Mississippi River Commission acquires two new dredges, for a total of nine.
- 1904—On 30 December, the St. Francis levee system is completed. By that time, the Mississippi River Commission has spent about \$57 million on 1,500 miles of levees.
- 1912—Devastating floods hit the lower Mississippi both years, bringing into question the continued reliance on levees.
- 1916—Another major flood occurs, generating increased interest in flood control legislation.
- 1917—The nation’s first flood control act authorizes \$45 million for the lower Mississippi and \$5.6 million for the Sacramento River.
- 1922—Flooding causes the Mississippi below the mouth of the White River to hit record stages. The St. Francis backwater area is also flooded.
- 1927—The most destructive flood ever to occur in the lower Mississippi takes between 250 and 500 lives, destroys over 25,000 commercial buildings and homes, and causes approximately \$236 million in property damage.
- 1928—Congress approves “An Act For the control of floods on the Mississippi River and its tributaries, and for other purposes.” Through this act, Congress instructs the Mississippi River Commission to implement the plan of Major General Edgar Jadwin, the Chief of Engineers, for controlling floods on the lower Mississippi. The plan is to be carried out “under the direction of the Secretary of War and supervision of the Chief of Engineers.”  
—The Mississippi River Commission Districts are reorganized. The First and Second Districts, plus the Dredging District, become Memphis District. The new District’s area covers nearly 200,000 square miles, including the entire drainage basins of the Arkansas and White rivers.



- 1932—Brigadier General Harley B. Ferguson, the new President of the Mississippi River Commission, initiates a program of cutoffs on the lower Mississippi.
- 1933—The Birds Point-New Madrid Floodway, authorized in the 1928 act, is completed; however, the Corps does not yet have all the necessary flowage rights.
- 1936—Congress passes the Overton Act, which authorizes flood control projects in the St. Francis basin in Arkansas and Missouri and in the Yazoo basin in Mississippi.
- The 1936 Flood Control Act recognizes that flood control is a “proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof.” The act authorizes a number of rivers and harbors projects which would be Memphis District’s responsibility.
- 1937—Memphis District is reorganized. The Arkansas River and tributaries above Pine Bluff and the White River and tributaries above Peach Orchard Bluff are served by Districts in the newly created Southwest Division.
- A “superflood” inundates the lower Mississippi. The Corps of Engineers blows the fuseplug levee in the Birds Point-New Madrid Floodway, eventually allowing about a quarter of the Mississippi’s flow past Cairo to enter the floodway and alleviating the danger to Cairo.
  - The 1937 Flood Control Act authorizes a project to protect Memphis from water rising over the banks of Wolf River and Nonconnah Creek.
- 1938—Work begins on the Wappapello Dam on the St. Francis River in Missouri and on new levees along the White River in Arkansas.
- 1944—Congress passes a flood control act which authorizes the dredging of a twelve-foot channel from Cairo to Baton Rouge.
- 1946—The 1946 Flood Control Act authorizes \$17 million for the Memphis harbor project, which includes closing Tennessee Chute with a dam.
- 1947—Work begins on Tennessee Chute project.
- 1950—The 1950 Flood Control Act authorizes three projects in Memphis District: to enlarge and improve the Cache River in Arkansas; to construct an earth levee, pumping station, floodgate, diversion ditches, and to relocate sewage facilities at Des Arc, Arkansas; and to protect the St. Francis backwater area.
- 1954—Work begins on excavating drainage ditches in the St. Francis basin.
- 1956—Memphis District initiates ten-year project to stabilize the Mississippi River around Memphis. The work is important as plans for a new bridge to carry the interstate across the Mississippi depend on it.
- 1964—Memphis District offices moved to a new federal office building.
- 1965—Dredges excavate part of Mud Island to prepare the Mississippi River for the construction of the Hernando DeSoto interstate highway bridge.

- 1966—Memphis District retires its last sternwheel steamboat, the snagboat *Arkansas II*.
- 1971—Construction begins on the W. G. Huxtable Pumping Plant, near Marianna, Arkansas. The \$26 million project is designed to pump water over a levee from approximately 2,000 square miles of the St. Francis basin interior.
- 1973—A major flood hits the lower Mississippi. Flood control structures prevent more than \$7.2 million in property damage.
- 1979—Mississippi River Commission celebrates its centennial.  
—Another major flood hits the lower Mississippi.



**US Army Corps  
of Engineers**  
Memphis District